SCIENCE ABSTRACTS.

Section A.—PHYSICS.

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SCIENCE ABSTRACTS.

Section A.—PHYSICS.

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GENERAL PHYSICS.

436. *Apparatus for Recording and Regulating the Humidity of the Air.* (Elektrotechn. Anzeiger, 28. pp. 207–208, Feb. 26, 1911.)—Various apparatus of S. W. Cramer, of Charlotte, N.C., combinations of a psychrometer and a Wheatstone bridge, are described; applications are not mentioned. The dry- and wet-bulb mercury thermometer are of the August type or of other types. Wires pass down the tubes and through the bulbs of both the thermometers; the mercury rising in one of the thermometers disturbs the balance, and the regulation is effected by adjusting the resistances in the third and fourth arms. H. B.

437. *Fixed and Differential Synchronisation Systems.* **E. Esclangon.** (Comptes Rendus, 152. pp. 170–173, Jan. 23, 1911.)—Instead of the common form of synchronous regulator, generally including an electromagnetic release, and involving a certain amount of mechanical shock to the wheel-train, the author suggests a magnetic clutch which simply acts as accelerator or retarder without any actual ratchet. By means of a supplementary mechanism to rotate the controlling magnets it is possible to devise a differential control by means of which a mean time seconds' pendulum can be made to distribute sidereal seconds. C. P. B

438. *Pressure-recording Indicator for Punching Machinery.* **G. C. Anthony.** (Amer. Soc. Mech. Engin., Journ. 33. pp. 75–83, Jan., 1911. Mech. Eng. 27. pp. 95–97, Jan. 27, 1911.)—The die is clamped firmly to a large piston which rests on a diaphragm enclosing oil whose pressure is transmitted directly to the piston of an indicator, the ratio of pressure- to indicator-piston being 2000. The travel of the punch through the plate is transmitted in the ratio of 5·5 : 1 to the indicator through an arc actuated by a finger which rests on the plate. A number of indicator diagrams are reproduced showing that the pressure rises to a maximum at a short distance in the plate and falls off as

the bar is pushed out. The effect of time is to delay the attainment of the maximum considerably. With a shearing punch the maximum is reached later than with a flat punch under identical conditions. The experiments show clearly that decreasing the clearance between the punch and the die increases the max. pressure. On one card for a ¾-in. flat punch on a ½-in. mild steel plate and only 0·017-in. clearance, the curve of falling pressure to expel the bar is actually convex in its general curvature, instead of concave as on the other cards. C. A. M. S.

439. *Regulator for Variations of Rotary Apparatus.* **E. Esclangon.** (Comptes Rendus, 152. pp. 82–85, Jan. 8, 1911.)—The action of the ordinary revolving-ball governor is modified by arranging the lifted weights as floats in mercury. For obtaining one fixed velocity these need only be in the form of vertical cylinders. If a range of velocities is desired the floats are inclined at adjustable angles by a system of linkage controlled by a scale and index, so that they can be set to regulate for any desired velocity. C. P. B.

440. *Effect of Temperature on the Compressibility of Metals.* **E. Grüneisen.** (Ann. d. Physik, 33. 6. pp. 1239–1274, Dec. 20, 1910. Communication from the Physikal.-Techn. Reichsanstalt.)—Experiments were made on the deformation of tubes of Fe, Cu, Ag, Pt, Al, Sn, and Pb by the application of internal pressure, using Mallock's method [see Abstract No. 2101 (1904)]. This method is reliable for investigating the effect of temperature on the compression moduli of hard metals; with soft metals the conditions are complicated by deformations and elastic phenomena. The metals were all tested from − 190° C. as the lower limit, to temperatures varying from + 16° to + 165° C. The results show that the compression modulus increases with the temperature, proportionally for some metals and faster for others, the temperature-effect being least at low temperatures, and greater for metals with a high expansion (or contraction) coefficient than for those with a low one. The theoretically necessary relations between the temperature coefficients of the various elastic constants are set out, and these appear to be of no value for deducing the temperature effect on the compressibility and on Poisson's ratio from the effect on the moduli of elasticity and rigidity: previously erroneous conclusions had been drawn from these theoretical considerations. In combination with, and partly agreeing with the results of other workers, it is concluded that when the metal is hard, generally at a temperature much below its melting-point, the volume and linear moduli vary very nearly as the temperature, so that Poisson's ratio approaches a constant which has characteristic values for the various metals. In the soft condition, that is at temperatures near the melting-point, or for metals which are never hard, the volume modulus increases more slowly than the linear modulus, so that Poisson's ratio increases with the temperature; the rise is hardly, however, so simple as expressed by Angenheister, who concluded therefrom that the melting-point is the temperature at which the ratio is ½. Earlier researches showed that, generally, there is no connection between Poisson's ratio and the melting-point of pure metals (as Schaefer's tables would suggest), consequently the reasons for a connection between the temperature-coefficient of Poisson's ratio and the melting-point fall to the ground. C. A. M. S.

441. *Action of Mercury on Steel at High Pressures.* **P. W. Bridgman.** (Amer. Acad., Proc. 46. No. 14. pp. 825–841, Jan., 1911.)—The experiments described demonstrate that hardened steel cylinders burst under internal pressure exerted by mercury, much more easily than for fluids such as water and glycerine because a process of amalgamation goes on. Soft steel does not show the phenomenon, since its yield-point is reached before the pressure can be raised high enough to produce the effect. The appearance of the fractures proved that amalgamation had taken place and experiments were made which showed that steel when broken under mercury is completely amalgamated, whereas the slightest contact with air has an enormous preventive effect. The spread of mercury through a hollow cylinder is produced partly by pressure and partly by the chemical affinity which is shown to be so marked. But the steel under pressure must be so strained as to distend the pores so as to allow the penetration to begin, and then distention facilitates the growth, which is most rapid in the direction in which the pores are most distended. In all cases where rupture occurs the strain is of such a type as to distend the metal, and when amalgamation is not produced by pressure the strain is compressive, closing the pores.

C. A. M. S.

442. *Air-resistance of Curved Surfaces.* **A. Boltzmann.** (Akad. Wiss. Wien, Sitz. Ber. 119. 2a. pp. 977–1009, June, 1910.)—The surfaces tested were chiefly rectangular in plan, and these were subjected, at varying angles of incidence, to an air current caused by a motor fan. The air current was passed through a tube 50 cm. wide, and its speed, measured by Recknagel's manometric method, varied between 2·4 and 2·6 m. per sec. The position, direction, and magnitude of the resultant air-resistance of the surface were obtained by means of a weighing method combined with manometer observations. The surfaces were perforated with a series of small holes situated along a median line. These were connected in turn to the manometer and the distribution of pressure over the surface thus obtained. The horizontal and vertical components of the air-resistance were obtained by means of special balances. The results are expressed in numerous tables and curves, and the value of the coefficient k is given, such that if P is the air-resistance in kg., γ the sp. gr. of air, g the gravity constant, F the area of the surface in sq. m., and v the velocity of the air in m. per sec., $P = k\gamma Fv^2/g$. G. E. A.

443. *Gravitational Permeability.* **T. Erismann.** (Archives des Sciences, 31. pp. 36–45, Jan., 1911.)—This research was undertaken to determine whether the gravitational attraction between two bodies depends upon the medium between those bodies. For this purpose a form of the Cavendish experiment was adopted, a large sphere of lead being used to attract the small spheres of silver carried on the arms of the torsion balance. These smaller spheres and the rod joining them could be surrounded by a jacket wholly intervening between them and the large sphere of lead. The substances used for the jackets were mercury, water, and paraffin oil, the experiments with and without the jacket alternating. The results were very concordant, and, to the degree of accuracy obtained (about 1 in 1000), failed to detect in the attraction any change due to the presence of any of the above-named liquids.

E. H. B.

444. *Turbulent Motion of Liquids.* **V. W. Ekman.** (Ark. för Mat. Astron. och Fysik, Stockholm, 6. 12. pp. 1–16, 1910.)—Experiments were made with the apparatus used by Osborne Reynolds with the view of redetermining the velocity at which turbulence commences. The velocity at which turbulent motion occurs was found to be higher the smaller the initial disturbances; with sufficient care it came out considerably higher than Reynolds' value. With the best experimental conditions, values of Reynolds' number N (= VD/1000ν, where V = velocity, D = diam. of tube, and ν = kinematic coefft. of viscosity calculated for distilled water) were obtained as high as 44, whereas according to Reynolds it should be 19·88. The whole of the experiments tend to the conclusion that there is no definite critical velocity at which approximately rectilinear flow changes into turbulent; but this velocity always increases with decreasing disturbances. Experiments were also undertaken to see whether fluctuations of pressure were an essential feature in the change from steady to turbulent motion; and it was found that the pressure-fluctuations were decidedly greater when the turbulent motion began than when the flow was steady. Analysis is given in the latter part of the paper explaining this phenomenon, and also dealing with the generation of disturbing vorticity. Two-dimensional flow is specially dealt with here; some further applications to the problem of stability of the equations obtained will be given in a subsequent paper.

A. W.

445. *Molecular Vibrations of Solid Bodies.* **A. Stein.** (Phys. Zeitschr. 11. pp. 1209–1212, Dec. 15, 1910.)—An hypothesis is put forward that, when with rising temperature the amplitude of vibration of the monatomic molecules reaches the half distance apart of the atoms, then melting begins. Thus, with two substances in equilibrium at the same temperature, we should have $m_1 n_1^2 a_1^2 = m_2 n_2^2 a_2^2$, where m, n, and a denote respectively mass of atom, frequency of its oscillation, and amplitude, the subscripts 1 and 2 distinguishing the substances. This view is tested by the data for a number of metals, the hypothesis being thus supported. [See Abstract No. 1889 (1910).]

E. H. B.

446. *Rigid Bodies in the Relativity Theory.* **M. Laue.** (Phys. Zeitschr. 12. pp. 85–87, Feb. 1, 1911.)—A discussion of the various views successively held as to rigid bodies in relativity theory. It was first defined by M. Born that on this theory a rigid body was one with 8 degrees of freedom; after criticisms, a second definition by the same author allowed 6 degrees of freedom. Later F. Noether concluded that a rigid body may be defined as a figure with 9 kinematical degrees of freedom. The present author shows that a three-dimensional figure has 10 degrees of freedom in four-dimensional space, of which 10, however, one is arbitrary. [See Abstracts Nos. 18, 1408, and 1570 (1910).]

E. H. B.

447. *Experimental Proof of Earth's Rotation.* **M. B. Latour.** (Cosmos, No. 1846, Nov. 12, 1910. Nature, 85. p. 248, Dec. 22, 1910. Abstract.)—Description of an apparatus devised by Hagen, consisting of a balanced wooden beam 9 m. long, with bifilar suspension. Attached to this are heavy masses movable in a horizontal plane, each consisting of 80 kg. of lead mounted in small wagons which can be released by fusing a lead wire. When released these run towards the centre, modifying the moment of inertia of the beam, and causing it to swing relatively to the earth. The motion is measured by means of a mirror attached to the suspension piece.

C. P. B.

448. *Earthquake of January 8, 1911.* **A. Angot.** (Comptes Rendus, 152. pp. 113–114, Jan. 9, 1911.)—This earthquake, which apparently had its epicentre among the Tian-Chan Mountains in Central Asia, was recorded at

the Parc Saint-Maur Observatory, and was the most intense disturbance thus far registered. The first and second preliminary tremors began at 23h. 34m. 44s. and 23h. 42m. 25s. respectively, while groups of large waves arrived at 23h. 46m. and 23h. 58m. For about 6 min. thereafter the oscillations were so large that the style frequently left the paper, indicating a total amplitude of ground movement of more than 0·8 mm. The disturbance diminished gradually, but was still to be discerned on the seismogram at 8h. 30m. on Jan. 4. The movements of the ground at Val-Joyeux were sufficiently great to disturb the magnetographs, all three instruments being sensibly affected.

A. D. R.

449. *Nitrates in the Antarctic Atmosphere.* **A. Müntz** and **E. Lainé.** (Comptes Rendus, 152. pp. 166–169, Jan. 23, 1911.)—The observations were made by R. E. Godfroy on the Charcot Expedition. The rain (and snow) contains more nitrates and nitrites in the tropics, where thunderstorms are frequent, than in Arctic regions, where thunderstorms are rare. Godfroy found about 0·225 mgm. of nitrates (calculated as HNO_3) per litre in the Antarctic rains, and 0·288 mgm. in the snow, the maximum being 0·4 mgm. He did not observe any thunderstorms nor auroræ, but winds from the north were frequent. Boussingault's figures for Alsace are: 0·184 mgm. of HNO_3 per litre in the rain, 0·48 mgm. in the snow, and 1·08 mgm. in mist; the average of Lawes and Gilbert for Rothamsted is 0·41 mgm. On the top of the Pic der Midi (altitude 2900 m.) Müntz and Aubin found hardly any nitrate in the atmospheric precipitates, the thunderstorms occurring there at a lower level; the average for Caracas (Venezuela) is 2·08 mgm. according to Müntz and Marcano.

H. B.

450. *Tidal Observations of the British Antarctic Expedition*, 1907. **G. Darwin.** (Roy. Soc., Proc. Ser. A. 84. pp. 403–422, Dec. 15, 1910.)—The paper commences with an account of the method adopted for observing the tides and for reducing the observations. It is shown that there is evidence of the existence of an oscillation with a period of about 8 days. This sea-seiche is supposed to be an oscillation in a large and deep bay—an arm of the sea which stretches over towards Weddell's Sea. The author estimates that this inlet probably has a length of some 25 or 30 degrees in latitude, and hence applying the method of Honda, Terada, and Isitani, he calculates that the bay must be 100 to 150 fathoms in depth.

A. D. R.

451. *Solar Rotation from Faculæ Measures.* **S. Chevalier.** (Astrophys. Journ. 32. pp. 388–399, Dec., 1910.)—Previous determinations of the solar rotation from the study of faculæ have been made by Wilsing and Stratonoff. The former inferred that the rotation was uniform for all altitudes, while the latter came to the opposite conclusion that the phenomenon known as the equatorial acceleration extended to the faculic stratum. To clear up the problem a new determination has been made by a thorough examination of the solar photographs at the Zô-Sè Observatory, China. All the negatives available for the period 1906–1908 were carefully scrutinised, and a certain number of pairs selected, the plates of each pair having an easily recognisable facula, from which positions were determined by means of projected charts. In all 572 plates combined in pairs have been utilised in the work, from which 5216 heliographic positions of faculæ have been determined. The resulting motions are presented in tables, and also as a diagram which very clearly indicates the equatorial acceleration. A very notable difference in the rotation values for the two hemispheres is unmistakably shown. The faculæ rotation velocities are found to be in general less than those given by Hale and Fox for the flocculi, and by comparison with the observations of Dunér it would appear that the rotation of the reversing layer is still more rapid than that of the flocculi. C. P. B.

452. *Jupiter and the Asteroids.* **E. W. Brown.** (Science, 33. pp. 79–93, Jan. 20, 1911. Paper read before the Amer. Assoc. for Advancement of Science, Dec. 28, 1910.)—An account is given of the periodicity of the asteroids from the point of view of forced vibrations, particularly of the nature of librations produced as periodic changes in which the variable is constrained to remain between definite limits. Kirkwood, of Indiana, pointed out that the gaps in the masses of asteroids occurred at or near the places where the periods are commensurable with the period of Jupiter. Taking the several groupings according to period, it is found that the majority of the asteroids are divisible into four main groups, with important discontinuities near the ratios 2:1, 7:3, 5:2; 3:1, this ratio representing the period of neighbouring asteroids to the period of Jupiter. An interesting extension of this grouping method is given for the system of Saturn. It is now known that the mean periods of the revolutions of Titan and Hyperion round Saturn are exactly in the ratio of 4:3, and that the actual periods librate about this ratio. Other interesting relationships are mentioned as existing between the perihelia of many of the asteroids and that of Jupiter. C. P. B.

453. *Mass Ratios in Stellar Systems.* **H. N. Russell.** (Astrophys. Journ. 32. pp. 363–371, Dec., 1910.)—In Barnard's discussion of the star system Krueger 60 [Abstract No. 1916 (1908)] it is pointed out that the motion of the principal component with respect to the distant optical companion is distinctly curved, indicating that the fainter companion has an appreciable mass. With these observations and some more recently communicated to the writer by Barnard a determination of the mass ratio has been made. A similar set of determinations are also given for the system of Castor. C. P. B.

454. *Nova Lacertæ and its Spectrum.* **T. E. Espin.** (Nature, 85. p. 319, Jan. 5, 1911. Abstract.)—By means of telegrams from the Centralstelle at Kiel it was announced that a new star had been discovered by T. E. Espin at Tow Law on Dec. 30, 1910, in the Constellation Lacerta. Position of Nova is RA = 22h. 32m. 9·5s.; Decl. = 52° 15′ 21″ N. **P. Idrac.** (Comptes Rendus, 152. pp. 173–174, Jan. 23, 1911.)—Photographic observations of the Nova spectrum have been made at Meudon with a prismatic camera, comprising a concave mirror of 25 cm. aperture and 75 cm. focal length, with an objective prism of 20° refracting angle. On account of bad weather only two exposures, of 10 and 45 min. respectively, were possible. On the photographs the hydrogen lines H_β, H_γ, H_δ, H_ϵ, H_ζ appear very bright and broad, attaining a width of about 40 Å. In H_β, H_γ, H_δ, a ray is seen of greater brightness, about 12 Å from the middle of the band and on the red side of the centre. Another strong band is near λ464. The spectrum is too narrow to detect the presence of dark lines. C. P. B.

455. *Variations of Brightness of Stars of δ Cephei Type.* **M. Luizet.** (Comptes Rendus, 152. pp. 70–72, Jan. 9, 1911.)—Dividing the stars of the δ Cephei class of variables into two main classes, depending on the presence or absence of a secondary maximum, the simpler class is further divided into five genera according to the shape of the light-curve. The typical stars are S Geminorum, W Ursæ Majoris, XX Cygni, RR Geminorum, and their individual light-curves are given in comparison with computed curves.
C. P. B.

456. *Photographic Determinations of Stellar Parallax.* **F. Schlesinger.** (Astrophys. Journ. 32. pp. 372–387, Dec., 1910.)—Almost all the determinations of stellar distances published up to the present time have been made with short-focus instruments, and it is of interest to examine the results obtained with a telescope of great focal length, in this case the Yerkes refractor, 40 in. aperture and about 60 ft. focal length. The plates employed were Cramer Instantaneous Isochromatic, 10 × 8 in., special precautions being taken to ascertain the degree of accuracy with which the optical axis was adjusted normal to the plate surface. To avoid certain well-known errors most of the plates were taken with the telescope west of the pillar, and not far from the meridian. In all 327 plates have been measured and reduced, relating to 25 different regions.
C. P. B.

457. *Motion of Stars in Space.* **P. Stroobant.** (Bull. Astronomique, Nov., 1910. Nature, 85. p. 282, Dec. 29, 1910. Abstract.)—The seven stars α Cassiopeiæ, β Persei, α Persei, α Scorpionis, δ Cygni, ε Pegasi, and α Pegasi are shown to be travelling towards a contracted polar area with velocities between 11 and 22 km. The sun is also moving towards this area with a velocity of 19·4 km.
C. P. B.

REFERENCES.

458. *Rigidity Definition.* **P. Ehrenfest.** (Phys. Zeitschr. 11. pp. 1127–1129, Dec. 1, 1910.)—A discussion of the definition of rigidity proposed by M. Born and criticised by v. Ignatowsky, the consideration all through being from the point of view of the principle of relativity. [See Abstracts Nos. 1728 (1909), 344 and 791 (1910).]
E. H. B.

459. *Hayford's Earth Ellipsoid.* **F. R. Helmert.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 2. pp. 10–19, 1911.)—The author discusses on the principle of least squares the accuracy of the published determinations of the United States Survey of the dimensions of the earth ellipsoid. He shows that the probable error is comparatively small, although about twice as much as stated by the investigators.
A. D. R.

460. *Theory of Spring Rock Drill.* **H. Kudo.** (Coll. Sci. and Engin., Mem. Kyoto, 2. 10. pp. 285–351, Sept., 1910.)—A full discussion of the theory of the spring drill as made by the Siemens-Schuckert Works, which is operated, through gearing, by an electric motor that serves to compress the springs.
L. H. W.

461. *Reversion Prisms for Double-star Measures.* **H. Struve.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 3. pp. 41–63, 1911.)—Discussion of a series of measurements of standard stars with and without reversion prisms.
C. P. B.

LIGHT.

462. *Direct-vision Intense Monochromator.* **H. du Bois.** (Zeitschr. Instrumentenk. 31. pp. 1–6, Jan., 1911. Communication from the Bosscha Laborat.)—Description of a direct-vision instrument constructed to give a bright monochromatic beam from any part of the spectrum. The dispersion is caused by a three-member prism, and the change of colour at the eyepiece is caused by a micrometer screw which moves objective and prism together. The readings of the screw are standardised by means of the sun's spectrum. G. E. A.

463. *Invisibility of Transparent Objects by Uniform Illumination. Simple Lecture Apparatus.* **W. Kaufmann.** (Phys. Zeitschr. 12. p. 29, Jan. 1, 1911.)—A funnel of white cardboard or of metal covered inside with gypsum, is placed on a stand and the inside illuminated by means of a glow-lamp. Up the axis of the funnel is fixed vertically a glass rod. A small slit is made in the side of the funnel. Looking through this slit the rod is quite invisible and only becomes visible on shifting either the lamp or the rod from the axis of the funnel. W. C. S. P.

464. *Sensibility of Interferometers. Improved Half-shadow Instruments.* **A. Cotton.** (Comptes Rendus, 152, pp. 131–133, Jan. 16, 1911.)—Whilst instruments using polarised light will detect a difference of λ/10000, ordinary interferometers will scarcely detect a difference of λ/100, due to irregularities of surface of the media traversed, to accidental variation in temperature, and to cruder method of measurement. A more accurate half-shadow instrument may be constructed by employing a modification of the apparatus described by Brillouin [Abstract No. 515 (1904)] in which the spars are thicker in order to have a sufficient distance between the two beams, monochromatic light is used instead of white light, and a half-shadow analyser of the Brace or Chauvin type is substituted for the Babinet compensator. Michelson's interferometer may be also improved by arranging one of the mirrors in two parts, parallel to each other, but one part very slightly behind the other—a result which may be achieved by either attacking the silver of the mirror, if sufficiently thick, or acting on the glass itself with hydrofluoric acid, as suggested by Rayleigh [Abstract No. 1084 (1908)]. All extraneous light, diffused or reflected, must be avoided so far as possible. W. H. Si.

465. *Application of the Gyroscope and Compressed Air to taking Kinematographic Views.* **G. de Proszynski.** (Comptes Rendus, 151. pp. 1342–1344, Dec. 27, 1910.)—The scope of the kinematograph for non-artificial views—in other words, its scientific utility—is at present very limited, owing to the necessity for posing the instrument on a very steady base. The tremblings which injure definition if the instrument is not sufficiently steady fall under four headings: (1) Movements of translation. (2) Oscillations around the optic axis. (3 and 4) Oscillations around axes perpendicular to the optic axis. The effect of (1) and (2) is negligible. To obtain a sharp impression it is sufficient to annul or reduce oscillations (3 and 4). This the author does by employing a gyroscope with its axis parallel to the optic axis of the apparatus. The requisite dimensions and velocity of the gyroscope may be calculated from consideration of the admissible maximum displacement of the impression on the plate in a given time, and of the forces due to shaking of the hand and weight of the apparatus. The gyroscope, however, only annuls short, rapid movements, and does little to counteract slow movements, such, for example, as are imparted to the apparatus by turning the handle. To avoid this inconvenience the author has constructed an automatic apparatus comprising a pneumatic motor, which is at once light, powerful, and very small. The air reservoir can be recharged by means of a small hand-pump.

A. E.

466. *Photometry and Use of Coloured Sources.* **J. Thovert.** (Comptes Rendus, 151. pp. 1347–1349, Dec. 27, 1910.)—A photometric measure is only really definite when made by monochromatic light. In principle the comparison of differently coloured sources should therefore be spectrophotometric. But we may conceive the numerical value of the total intensity to be obtained from the monochromatic intensities by allotting, in the summation, to each colour a particular coefficient, which may be called the coefficient of utilisation. The author has selected the distinct vision of forms as a characteristic phenomenon from which to deduce the relative values of this coefficient for different radiations, and on this basis he has investigated the law of utilisation for the radiations of a Carcel lamp. A grating spectroscope is employed, having its ocular replaced by a slit conjugate to the slit of the collimator. In the monochromatic field a transparent lamina, with a pattern traced on it, is placed at the distance of distinct vision. The illumination of the collimator slit is graduated by suitable means, such as covering the slit with ground glass and regulating the distance of the lamp. For each step of illumination the wave-lengths are found which correspond to the limit of distinct vision of the pattern placed in the field. From the observations is deduced a curve of utilisation, measured by the inverse of the illumination corresponding to the limit of distinct vision for each radiation. In comparing different curves the max. utilisation (or minimum illumination) is taken as unity. The unique curve of utilisation of the Carcel lamp may, with sufficient accuracy, be regarded as a pair of straight lines symmetrical with regard to the wave-length, 580 $\mu\mu$, of max. sensibility. The inclination $du/d\lambda$ of either line may be taken as 1/100, if λ is expressed in $\mu\mu$. Observations with direct sunlight and with an Auer mantle give curves of the same form as the Carcel; but the max. utilisation, or axis of symmetry, is near 565 $\mu\mu$ for the sun and near 570 for the Auer. The curve for the sun closely resembles Abney's relative luminosity curve. A curve of colour sensitiveness may be obtained with the spectroscope by producing the spectrum on ground glass and interposing a series of graduated grey tints. The length of the spectrum decreases with the depth of the tint interposed. By noting the extreme wave-lengths of the spectrum obtained with each tint the curve is determined. That the curve of colour sensibility does not give such accurate results as the curve of form sensibility appears from the fact that the place of max. sensitiveness for each of the three sources, sun, Auer, and Carcel, is nearly the same, lying in the green somewhere between 530 and 550 $\mu\mu$.

A. E.

467. *New Element in the Earths of Gadolinite.* **G. Urbain.** (Comptes Rendus, 152. pp. 141–143, Jan. 16, 1911. Chem. News, 103. p. 73, Feb. 17, 1911. Abstract.)—By continuing the fractionation of the earths of gadolinite by the crystallisation of the nitrates, after a great number of crystallisations some drops of mother-liquor were obtained which would not crystallise. After purification the coefficient of magnetisation of the earth derived from this liquid was measured, and was found to be only $4{\cdot}1 \times 10^{-6}$, whereas that for the oxide of lutecium is three or four times as great. Spectrographic analysis revealed a number of lines not due to lutecium, scandium, or others of the group, or to any known substance, and hence the author concludes a new element must be present, to which he has given the name *celtium*. The chloride of this substance is rather more volatile than the chloride of lutecium, but less volatile than that of scandium. Its hydroxide is a weaker base than lutecium oxide, and a stronger base than scandium oxide. In all other characteristics the earth shows an equal resemblance to lutecium and scandium. The strongest lines of the arc spectrum between $\lambda = 2450$ and $\lambda = 3700$ are as follows:—

2459·4	2677·7	2765·8	2870·2	2949·5	3197·9
2469·3	2685·2	2834·8	2885·1	3080·7	3326·0
2481·6	2729·1	2837·3	2906·9	3118·6	3391·5
2536·9	2737·9	2845·2	2931·7	3171·4	3665·6

A. W.

468. *Positive Magneto-optic Effect of Phosphorescence Bands of the Ruby and Emerald; Emission and Absorption in a Magnetic Field.* **J. Becquerel.** (Comptes Rendus, 151. pp. 1344–1347, Dec. 27, 1910, and 152, pp. 183–186, Jan. 23, 1911.)—In some points the author's investigations do not confirm those of du Bois and Elias [see Abstract No. 67 (1909)]. Only cases where the luminous pencil, the magnetic field, and the optic axis are all parallel are here considered: (1) It is known that, in the case of the ruby, the whole group of emission bands between 690–705 $\mu\mu$ is reversible, *i.e.*, is also found in the absorption spectrum. Further, each phosphorescence band undergoes identically the same magnetic decomposition as the corresponding absorption band, and the state of circular polarisation of the components is the same. According to du Bois and Elias, in the case of the ruby lines 691·8 and 693·2, the circular polarisation would be total for absorption, but very incomplete for phosphorescence; a result which would have important theoretical consequences were it true. The author, however, finds that the circular polarisation *is total both for phosphorescence and for absorption.* (2) In all cases where precise measures have been made, it has been established that the change of period produced by a magnetic field is independent of temperature. According to du Bois and Elias, the ruby band 693·2 would form an exception. The author finds this conclusion also to be unjustified. It appears that the band 693·2 splits into an unsymmetrical triplet. At a very low temperature the components are easily separated, but at high temperatures they broaden and tend to merge, rendering it necessary to measure the separation by indirect means which are liable to yield too small a result. (3) The ruby and emerald furnish interesting examples of unsymmetrical decompositions. Instances are, the above ruby line 693·2 (in which with field 25,000 gauss and temperature —190°, the medial band *a* is shifted 0·02 away from the violet from the position of the primitive band, and the component *b*, next the violet, is sharper and fainter than *c*), and the emerald line 679·4 (in which the component on the violet side is the intenser). The ruby bands of absorption (not phosphorescence) 474·6 and 476·3 show marked dissymmetry of intensity, the intenser component being next the violet. This kind of dissymmetry is known to be nearly general at low temperatures, and to increase as the temperature diminishes. (4) The influence of the magnetic field has so far only been observed on reversible lines of phosphorescence. No non-reversible lines studied—lines of uranyl salts, for instance—have shown the least change. (5) All the bands of sensible phosphorescence give a positive effect, *i.e.*, opposite in sign to the sign predicted for the vibrations of negative electrons. Though the number of bands observed is too small for inference of a general rule, the fact is worth noting. In the second paper the author mentions another point, an important one, of disagreement between his results and those of du Bois and Elias. He finds no difference between the longitudinal and transversal observations of the position and intensity of the magnetic components of the same line or band (emission or absorption). Certain instances in which du Bois and Elias found a difference between the longitudinal and transversal effects he ascribes to erroneous adjustment, the crystal being set obliquely. Du Bois and Elias give 9 principal cases for uniaxial crystals (2 principal spectra), according to the relative orientations of the optic axis, the magnetic lines of force, and the luminous pencil. The author states that these 9 cases are not all different, and reduces them to 5, viz.: Optic axis parallel to the field (2 cases): ordinary (Fresnel) vibration normal to the field; extraordinary vibration parallel to the field. Optic axis normal to the field (3 cases): ordinary vibration parallel to the field; ordinary vibration normal to the field; extraordinary vibration normal to the field. A. E.

469. *Effect on Fluorescence of Iodine and Mercury Vapour of Admixture of Gases having different Affinities to the Electron.* **J. Franck** and **R. W. Wood.** (Deutsch. Phys. Gesell., Verh. 13. 1. pp. 78–88, Jan. 15, 1911.)—Warburg's hypothesis explains the fact that the current obtained with negative point discharge is much stronger in gases when freed from oxygen than when slightly adulterated with oxygen, by supposing that in the pure gases the carriers of the negative charge are unencumbered electrons, which have therefore great velocity; small quantities of oxygen by condensation on the electrons increase their mass, and therefore lower their velocity. The affinity to the electron, *i.e.*, the force acting between the neutral molecule and the electron, diminishes from the strongly negative gases down to the "noble" gases. In the latter it appears to be zero. A connection between affinity to the electron, and influence on the emission of spectral lines, seems probable. The object of the present work is to prove that forces, which in the case of free electrons colliding with neutral molecules, produce a union of mass sooner or later according to the affinity of the molecule to the electron, can also damp more or less, or completely deaden, the vibrations of bound electrons. The results for admixture of the gases He, Ar, H, N, air, O, CO, ether, and Cl, are shown by curves in which the ordinate represents the intensity of fluorescence, and the abscissa the pressure of the added foreign gas. The gases are given in order of increasing effect in weakening fluorescence. Thus He weakens it much less than hydrogen, though twice as heavy, and argon (atomic weight 40) also has somewhat less effect than hydrogen (at. wt. 2). Cl (at. wt. 70) weakens the fluorescence most of all, more than ether (at. wt. 75). Thus the order of the gases has nothing to do with their atomic weight, but is mainly determined by their electronic affinity. This confirms the authors' theory that the vibrating electrons in the molecule are influenced similarly to the free electrons. Pohl and Pringsheim have simultaneously arrived at a like conclusion for the frequency and damping of the resonance electrons of the selective photo-effect. The following fact is also confirmatory. With increasing admixture of He, the fluorescence, at first green, becomes more and more red. Two intersecting curves, red and green, are given for He, which were obtained by the use of separate colour-filters. A very slight change of tint was observed in the other gases, being plainest in Ar and H. A disturbance of the electron vibrations would naturally occur on collision with a foreign gas, and this disturbance reveals itself by the emission of other wave-trains. Hence the change of tint. If the foreign colliding gas is strongly electro-negative, like Cl, then the electronic vibrations are so strongly damped as to be unobservable: there is only emission from such of the iodine molecules as lie outside the sphere of action of the Cl particles, and these become fewer with increasing pressure. Hence the intense weakening of fluorescence. The nature of the change of colour is discussed more closely in another paper [see next Abstract]. Experiments were also made with Hg vapour, but only qualitatively. Quartz tubes, ultra-violet light, and high temperature were required. Mercury is very electro-positive, and its fluorescence was found to be very sensitive to admixture of electro-negative gases. In the presence of O at only 8 mm. pressure no fluorescence could be obtained, while He at a pressure of a whole atmosphere did not dim the fluorescence at all. An explanation is advanced for the fact that in Wood's experiments the optima of intensity of fluorescence lie at such very different pressures in different vapours, even when no foreign gas is present. In order to yield visible fluorescence, enough emitting molecules must be present. But their number must not be so great that they interfere with one another. In strongly electro-negative gases the vibrating molecules can easily interfere. Hence in Br, which is extremely electro-negative, the optimum lies at a very low pressure; in iodine at $\frac{3}{10}$ mm., while in Hg, which is strongly electro-positive, the optimum is not attained even at a pressure of several atmos. A. E.

470. *Transformation of the Resonance Spectrum of Iodine Fluorescence into a Banded Spectrum, by Admixture of Helium*. **R. W. Wood** and **J. Franck.** (Phys. Zeitschr. 12. pp. 81–88, Feb. 1, 1911. Phil. Mag. 21. pp. 265–268, Feb., 1911.)—[See preceding Abstracts and No. 841 (1911).] The weakening of intensity of fluorescence on addition of He, is much less in iodine vapour than in other gases. Even with He at a pressure of 80 mm. of mercury, the fluorescence is still visible, though weak and quite red instead of green as when He is absent. On adding to iodine vapour He at pressure 2 mm., the fluorescence appears visually almost unchanged, both in intensity and colour, whether excited by white or monochromatic light. But the spectroscope reveals a striking change. If the green Hg line be used to excite the fluorescence, the resonance lines proper to this source of excitation appear much weakened, and in addition to them appears a full banded spectrum such as is seen with a white exciting source. On raising the pressure of the added He to 10 mm., traces only of the original resonance spectrum are now seen, and the fluorescence spectrum is practically identical with that excited by white light. A print is given in illustration. In the case of Cl the much more rapid decrease of the resonance spectrum is not accompanied by the appearance of the banded spectrum. The duration of exposure for the iodine spectrograms was 18 hours for the Hg lamp, and 1 hour for white light. The phenomena can be observed with a small direct-vision pocket spectroscope, if the rays from the Hg lamp be condensed on the vapour tube by means of a large projection lens. Each "resonance series" of the spectrum may be conceived to be emitted by one particular system of electrons, which resound to one particular wave-length, that of the exciting ray. Thus, with monochromatic light we obtain a single series; with white light a banded spectrum the sum of all the series. Suppose that the collision with a helium atom so disturbs the structure of the iodine molecule that the systems of electrons become entangled, then when one system is excited by a given wave-length from an external source, all the other systems are forced to emit their vibrations also. In the process, energy is given up by the system primarily excited to the other systems. A strongly electro-negative gas, like Cl, causes similar disturbance, but exercises influence on the electrons which prevents the vibration of those coming within its sphere of influence. The change of colour of the fluorescent iodine on addition of He may be explained by energy being given up by the original green direct-resonance radiation, to the yellow and red portion of the new resonance spectrum. The point is emphasised that the collision of the He atom does not produce the emitted radiation, for then a mixture of He and I would continually emit energy; but the collision facilitates transfer of energy in the iodine molecule from one vibrating system of electrons to another. A. E.

471. *Thermoluminescence.* IV. **C. A. Pierce.** (Phys. Rev. 32, pp. 115–125, Jan., 1911.)—The author investigates the origin of the decay curve of phosphorescent substances, which, on plotting times against $1 \div \sqrt{I}$, shows two straight line portions with a curved link between them. The method used was that of a photometric examination of the spectrum band. The conclusions arrived at are: that the fluorescence and phosphorescence bands of Sidot blende coincide with each other; that no change in the position of the fluorescence band occurs with decay, nor under the action of infra-red rays, nor with change of temperature; that these agencies do not change the shape of the band; and that, in the case of Balmain's paint, no change occurs in the position or shape of the band with decay. These results tell against the theory which attributes the two-line curve to two bands coming into action successively. [See Abstracts Nos. 2208 (1905) and 1246 (1910).] E. E. F.

472. *Luminescence Spectra of Fluorites.* I. **A. Odencrants.** (Ark. för Mat. Astron. och Fysik, Stockholm, 6. 27. pp. 1–36, 1910.)—Four fluorites of widely different appearance (optically clear, dark reddish violet, greenish white, and pale violet) were excited with radium, kathode, and canal rays, and with light. The thermoluminescence after radium excitation was also investigated. In all these cases spectra were obtained consisting of groups of bands or rather broad bands with several maxima. The wave-lengths of the maxima agree for the different spectra, but the relative intensities vary considerably sometimes even to disappearing), both for different specimens and for different excitations. Further, the spectra agree in many points with those obtained by E. and H. Becquerel, Liveing, and Urbain, for photo-, photothermo-, and kathodo-luminescence; while the sharp lines of Morse show a marked concentration within the limits of the groups. The bands also agree well with those obtained by Urbain for artificial fluorides prepared from rare earths dissolved in Ca; in some cases much more closely than the bands observed by him for natural fluorite. This fact supports Urbain's view that the luminescence is due to the presence of rare earths. A broad continuous spectrum, seemingly independent of the bands, and partly covering them, was also observed in all cases, thermoluminescence excepted. Several other investigators have also obtained this continuous band, which some writers have classed as fluorescence. It appears, however, not to be due to fluorescence, at least not always. A maximum of intensity is observed about

2800. The limit on the violet side is about 2800, that on the red side is more variable. The bands observed by the author and other investigators, are given in tables and diagrams. The paper includes an historical *résumé* of previous work on the subject. A. E.

473. *Rate of Decay of Gas Phosphorescence.* **C. C. Trowbridge.** (Phys. Rev. 32. pp. 129–151, Feb., 1911.)—This paper contains the results of a series of measurements of the rate of decay of the gaseous afterglow which is produced by the electrodeless ring discharge. The method of determining the intensity of the phosphorescence consists in a direct comparison of the luminosity of the phosphorescent gas contained in a glass bulb with a screen which is illuminated by an electric light of known candle-power. The novel part of the apparatus is the mechanism for moving the photometer carriage which carries the electric lamp so that a number of different photometric settings can be made in quick succession: seven different intensities can by the means described be recorded in 10 sec. It is found that the decay of the phosphorescence in air and nitrogen is expressed by the relation $I = 1/(a + bt)^2$. The curves obtained by plotting the values of $I^{-\frac{1}{2}}$ as ordinates, and the corresponding values of t as abscissæ are approximately straight lines for a considerable range of t. A small variation has, however, been observed in many cases, the curve formed being slightly convex towards the axis of t. In other cases the rate of decay seems to change at one point only, as if there were two rates of decay, the more rapid being that for long-time phosphorescence. The phosphorescence of a gas increases very rapidly in intensity with increase of gas pressure. This is apparently true up to a point at which the gas pressure is such that the exciting discharge ceases to produce the glow. The relation between the initial intensity of the phosphorescence and the gas pressure is $I_0 = Cp^3$. When the phosphorescence is formed at various pressures the rate of decay decreases as the pressure is reduced, and reaches a minimum where the glow is most persistent. From thence it decreases to the lowest pressures. In general the intensity of gas phosphorescence becomes greater with an increase of either the intensity or the duration of the exciting electrical discharge. The results of these experiments make it apparent that the afterglow formed by the electrodeless ring discharge is a phenomenon which is of the same nature as the phosphorescence which occurs in solids. A. E. G.

474. *Theory of Fluorescence.* **A. V. Bäcklund.** (Ark. för Mat. Astron. och Fysik, Stockholm, 6. 19. pp. 1–30, 1910.)—The author works out a theory of radiant heat and electric action differing from Bjerknes' analogy by considering the ether as a perfect gas instead of an incompressible fluid. Material particles are regarded as spheres of comparatively infinite density, capable of pulsating in such a manner that they change their size periodically, but retain their spherical shape. Each sphere consists of a "point sphere" surrounded by a gaseous envelope whose density is very small. This has an external layer of much greater density (say, of the order of the density of water), but infinitesimally thin. The nucleus itself is rigid, but the gaseous envelope is yielding, and on being exposed to a temporary pressure over its whole surface will be thrown into pulsations as described. These pulsations produce waves in the ether, which are propagated with the velocity of light. With this mechanism the author explains how heat is communicated from one molecule to another. Atoms differ from each other and from electrons by their proper periods of vibration. Fluorescence is due to the motion of the electrons of a thermal conductor. E. E. F.

475. *Radiation, Ionisation, and Luminescence of Quinine Sulphate.* **de Broglie** and **L. Brizard.** (Comptes Rendus, 152. pp. 166–168, Jan. 16, 1911.)—Comparison of the electrical and luminous effects produced by placing quinine sulphate between the plates of a condenser (1) in the ordinary atmosphere, (2) *in vacuo,* and (3) in an atmosphere of hydrogen, shows that the intensity of the phenomena is greater in both the latter cases than in the ordinary atmosphere, and it is concluded that the scintillations are due to small electric discharges produced at the moment of rupture of the crystals—a theory which is in agreement with the views of Tommasina [Abstract No. 291 (1904); see also Abstract No. 289 (1904)]. W. H. St.

476. *Fluorescence and Phosphorescence to —190° C.* **E. L. Nichols** and **E. Merritt.** (Phys. Rev. 32. pp. 38–58, Jan., 1911.)—A continuation of the previous work of these authors in studies of luminescence, the results being here recorded in fourteen diagrams, some of which include a number of graphs. The temperatures cover the range from 20° to —190°, the substances dealt with being ZnS, barium sulphide with traces of Cu and Li, fluorescein, willemite, resorufin, strontium sulphide with barium as active metal and a sodium salt as flux. [See Abstracts Nos. 555, 810, 914, 1714, 1715 (1910).] E. H. B.

477. *Distribution of Secondary Röntgen Radiations round the Radiator.* **J. A. Crowther.** (Cambridge Phil. Soc., Proc. 16. pp. 112–120, Feb. 15, 1911.)—A preliminary account of experiments made to determine the relative intensity of the secondary rays in different directions round the radiator. The radiations from a substance under the influence of Röntgen rays may be divided in general into two classes: (1) the "scattered" radiation, and (2) the "homogeneous" radiations, the former being distinguished by having the same absorbability as the radiation producing it; the latter by an absorbability which is independent of the primary rays and characteristic of the radiator. Both types of radiation are here investigated. The ionisation chamber is cylindrical in shape, and is closed at one end by a thin Al window, 4 cm. in diam., to admit the radiations. In order to obtain the "saturation" current with a reasonably low voltage a system of plane electrodes of thin Al leaf mounted on wire rings is employed instead of the usual central wire electrode. The ionisation chamber is mounted so that it can be revolved about the radiator while the latter remains fixed, the Al window always facing the centre. It is shown that the scattered radiation reaches a maximum both forward and backward in the direction of the primary beam, and falls to a minimum at right angles to that direction. At any given inclination to the primary beam there is always a preponderance of radiation in the forward direction, that is to say, on the opposite side of the radiator to that upon which the primary rays first fall. This preponderance increases the nearer we approach the direction of the primary beam. The characteristic secondary radiations are emitted equally in all directions round the primary beam. A. E. G.

478. *Heating Effect of Radium.* **H. Pettersson.** (Ark. för Mat. Astron. och Fysik, Stockholm, 6. 26. pp. 1–9, 1910.)—The author has redetermined the heat emission of a quantity of 86·5 mgm. $RaBr_2$ which Ångström [Abstract No. 2228 (1905)] found gave off heat at the rate of 117 gm.-cals. per hour per gm. Ra [see also Abstracts Nos. 458, 1078 (1909)]. The electrical compensation calorimeter method was employed, and the value 116·4 ± 0·8 per cent.

gm.-cals. per hour was obtained as the heat produced per gm. Ra for all the radiations absorbed by 4 mm. of lead, *i.e.*, the whole of the α- and β-rays. By using a calorimeter of thin Al the author determined indirectly that the β-rays contained energy equal to 8·1 gm.-cals. per hour per gm. Ra, while by a direct method in which the heating effect of the β-rays alone was measured the value 2·7 was obtained. The mean result shows that the β-rays give rise to 2·5 per cent. of the total heating effect of Ra. The author hopes to determine the absorption of β-rays by matter by the determination of the heating effect. E. M.

479. *Radium-content of Salts of Potassium.* **J. Satterly.** (Cambridge Phil. Soc., Proc. 16. pp. 67–70, Feb. 15, 1911.)—Campbell has shown that the salts of potassium are radio-active; that they emit β-rays of velocity less than the β-rays of uranium; and that the activity of potassium measured by its ionising power is about 1/1000 of that of uranium as measured by the ionisation caused by the β-rays from that substance [Abstract No. 1852 (1907)]. Campbell's method of investigation was, however, such that the main volume of the emanation generated was overlooked. The present experiments, which are arranged to measure the absolute amount of radium in potassinm, avoid this source of error. The mean result shows that 1 gm. of potassium salt contains about 8×10^{-14} gm. of Ra: the radium-content does not seem to bear any ratio to the percentage of potassium in the salt; it is probably a mere accidental impurity. If the activity of potassium salts were solely due to Ra, $0{\cdot}5 \times 10^{-9}$ gm. of Ra per gm. of salt would be required. Since these experiments show that the actual amount of radium is only about 1/10000 of this, Campbell was justified in considering potassium to be radio-active. A. E. G.

480. *Rays and Product of Uranium X.* **F. Soddy.** (Phys. Soc., Proc. 22. pp. 57–66; Discussion, pp. 66–67, May, 1910.)—The paper contains a fuller account of the experiments described in Abstracts Nos. 472 and 1051 (1909) to test whether an α-radiating product is produced as the β-radiation of UrX decays. The preparations of UrX were examined in a strong magnetic field to deflect all the β-rays, and a residual α-ray activity was found which remained sensibly constant for nearly a year. The author concludes that the parent of Ra cannot be the direct product of UrX. The later experiments described in the paper (with improved apparatus), have shown the result described in Abstract 1051 (1909) to be untrustworthy, and it is withdrawn provisionally. E. M.

481. *Mesothorium.* **W. Marckwald.** (Ber. Deut. Chem. Gesell. 43. p. 3420, 1910. Chem. News, 103. p. 13, Jan. 13, 1911.)—Hahn has shown [Abstract No. 1647 (1907)] that thorium on undergoing radio-active disintegration produces MesoThI, which is converted with a half-time period of 5·5 years into MesoThII, whose half-time period is 6·2 hours, and which gives off β- and γ-rays in producing Radio-Th. The present paper deals with the properties of MesoThI, which is shown to be chemically analogous to Ra, no method of separation having been found. Thus the Ra obtained from Th ores rich in Ur, as, for example, thorianite, always contains MesoTh, while the MesoTh preparations obtained from monazite must contain Ra owing to the presence of Ur. The method of testing the relative proportions of Ra and MesoTh in a sample is to heat it or evaporate the solution to drive off the RaEm, the ratio of the γ-ray activities before and after treatment

being a measure of the proportion. MesoThII can be separated from MesoThI by adding a trace of iron chloride to the aqueous solution of the salt and adding ammonia, the MesoThII being precipitated with the iron hydroxide. E. M.

482. *Half-period of Actinium C.* **A. F. Kovařik.** (Phys. Zeitschr. 12. p. 88, Feb. 1, 1911. From the English.)—The author has made about 150 measurements of the half-period of AcC obtained by the back-kick method [see Abstract No. 649 (1909)] from the active deposit of actinium. Very concordant results were obtained, a probability curve being drawn which gave the value of the half-period to be 4·71 min. None of the observations reached the value 5·1 min. previously obtained by Hahn and Meitner [Abstract No. 1961 (1908)]. E. M.

REFERENCES

483. *Gauss-Poggendorff Method for Measurement of Small Angles.* **L. Geiger.** (Phys. Zeitschr. 12. pp. 66–70, Jan. 15, 1911.)—Describes a method of increasing the sensitiveness of the Gauss-Poggendorff rotating mirror method for the measurement of small angles, use being made of the principle of auto-collimation. A. W.

484. *On Cusped Waves of Light and the Theory of the Rainbow.* **W. B. Morton.** (Phys. Soc., Proc. 23. pp. 58–65; Discussion, p. 65, Dec., 1910.)

485. *Adjustment for Plane Grating Similar to Rowland's Method for Concave Grating.* **C. Barus** and **M. Barus.** (Amer. Journ. Sci. 31. pp. 85–95, Feb., 1911.)

486. *Magnetic Birefringence of Pure Liquids. Comparison with the Kerr Phenomenon.* **A. Cotton** and **H. Mouton.** (Journ. de Physique, Ser. 5. 1. pp. 5–52, Jan., 1911.)—A more complete account of work previously dealt with [see Abstracts Nos. 809, 898 (1910)].

487. *Emission and Absorption of Luminescent Hydrogen.* **R. Ladenburg.** (Phys. Zeitschr. 12. pp. 5–9, Jan. 1, 1911.)—A *résumé* of the results given in a previous paper [Abstract No. 1453 (1910)] in support of the argument that the ratio of emissivity to absorbing power is not constant within the reversed spectrum lines of hydrogen. [See also Abstracts Nos. 1776 (1908), 1869 (1909), and 1431 (1910).] G. E. A.

488. *Ultra-violet Fluorescence and Chemical Constitution of the Cyclic Compounds.* **H. Ley** and **K. v. Engelhardt.** (Zeitschr. Phys. Chem. 74. 1. pp. 1–64, 1910.)

489. *Ratios which the Amounts of Substances in Radio-active Equilibrium bear to one another.* **H. Mitchell.** (Phil. Mag. 21. pp. 40–42, Jan., 1911.)—Mathematical.

HEAT.

490. *Optical Temperature Measurements.* **M. v. Pirani.** (Deutsch. Phys. Gesell., Verh. 13. 1. pp. 19–26, Jan. 15, 1911.)—A simple arrangement is described for determining the true temperature and absorbing power of bodies. A carbon tube is heated electrically; a hole is made through the wall of the tube and alongside of it a square mm. of the material is embedded in the outer wall. When the tube is incandescent the radiation through the hole is brightest, that from the outer wall is darker and, as a rule, that from the embedded mass darkest. The temperature of the carbon tube is found by means of a Holborn-Kurlbaum pyrometer, and the black temperature of the metal and its absorbing power are calculated. Numerical results are given for a modification of the method in which the tube is enclosed in a glass cylinder through which a current of nitrogen is passed. [See also Abstract No. 820 (1910).] G. E. A.

491. *Absolute Expansion of Mercury.* **H. L. Callendar** and **H. Moss.** (Roy. Soc., Phil. Trans. 211. pp. 1–32, March 7, 1911.)—Sixty-four years ago Regnault published his well-known results, using two balancing hydrostatic columns, since when nothing has been seriously attempted on the same lines; though, using the weight-thermometer method, Chappuis obtained results with modern appliances [Abstract No. 686 (1908)]. In place of one hot and one cold column of mercury the authors use six hot and six cold columns placed in series. Each column is 2 m. long, giving an effective length of 12 m. Thus eight times as great an expansion is obtained as in Regnault's apparatus. All the hot columns are placed side by side in a vertical iron tube, and in a similar tube are placed the six cold columns. The eleven junctions between hot and cold were of steel tube with special joints. The heating was performed electrically, the oil surrounding the columns being stirred continuously. The Pt thermometer used for giving the hot and cold temperatures extended for 2 m. by the side of the columns, giving the true mean temperature. The method of filling is to have glass tubes with taps attached to the steel joining tubes and, after evacuation, to run mercury into the lower taps. Tests, made specially, show that air-bubbles can be practically eliminated by this means. The range of temperature used in the experiments is from $-80°$ C. to 309° C. The results are given (*a*) in the terms of ${}_0a_t$, which stands for the mean coefficient of expansion between 0° and $t°$, and (*b*) in volume at any temperature $t°$ of mercury which at 0° C. is 1 cm.^{3} The standard formula adopted is the parabolic form—

$${}_0a_t = [1805553 + 12444(t/100) + 2589(t/100)^2] \times 10^{-10}$$

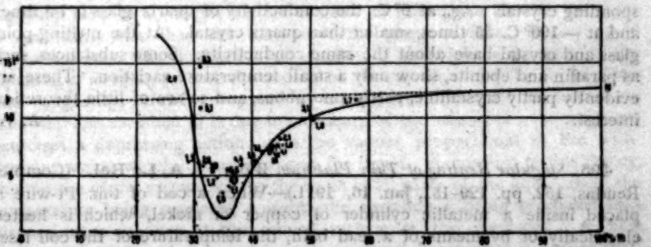
and the fundamental coefficient ${}_0a_{100} = 0{\cdot}0001820586$. An approximate simple formula is given ${}_0a_t = (18006 + 2t) \times 10^{-9}$. The results agree better for the 0° to 100° range with those of Chappuis than with those of Regnault or with Regnault's as reduced by Broch. But for the range 150° to 300°, the present results agree very closely with those of Regnault, as reduced by himself, fairly closely with Wüllner's reduction of Regnault's results, and very badly with Broch's reduction of Regnault's results. The expansion obtained from this research is based on the formula $t - pt = 0{\cdot}000150t(t - 100)$ for reducing platinum temperatures to gas-thermometer temperatures ; and on the fundamental temperature of boiling sulphur as being 444·58° C. **P. E. S.**

492. *Density, Coefficient of Expansion, and Change of Volume on Fusion of the Alkali Metals.* **L. Hackspill.** (Comptes Rendus, 152. pp. 259–262, Jan. 30, 1911.)—The author has measured the coefficients of expansion by distilling the metals *in vacuo* into a bulb attached to a graduated tube, similar to a thermometer, and noting the position on the scale at various temperatures. In the case of the solid metals, the bulb was incompletely filled with the metal, and the volume made up with pentane, toluene, or naphtha. The following are the results obtained :—

	Caesium.	Rubidium.	Potassium.	Sodium.
Specific gravity at 0° C. ...	1·9029	1·5248	0·859	0·9725
Coefficient of expansion of solid metal..................	0·000291	0·00027	0·00025	0·000216
Per cent. increase of volume on fusion	2·32	2·28	2·42	1·50

The coefficient of expansion of liquid Cs is 0·000341 between 28° and 50°, and 0·000348 between 50° and 128° ; of liquid Rb 0·000339 between 40° and 140° ; of liquid K 0·000280 between 70° and 100°, and 0·000285 between 100° and 150° ; and of liquid Na 0·000275 between 100° and 180°. W. H. Si.

493. *Anomalous Expansion of Nickel Steel.* **C. E. Guillaume.** (Comptes Rendus, 152. pp. 189–191, Jan. 23, 1911.)—The author has continued the study of the expansion of nickel steel [see Abstract No. 1550 (1902)] and has examined over 300 samples of the normal "reversible" alloys which contain about 1 per cent. of carbon, Si, and Mn, of which about 0·5 per cent. was Mn. All the samples were forged and cooled slowly in air. The true results for the coefficient of expansion were calculated from the numerous observations by the method of least squares and plotted as an expansion-concentration curve as shown in the accompanying diagram. In order to show clearly the minimum in the curve, the expansion of iron-nickel has been calculated from the figures for the pure metals and plotted in the line F-N. The effects of Mn and Cr were also determined, the results obtained for the Mn alloys being indicated by circles and for the Cr alloys by means of crosses ; the figures indicating the Mn- and Cr-contents respectively. **F. C. A. H. L.**



494. *Temperature Variation of Heat Conductivity of Non-metals.* **A. Eucken.** (Ann. d. Physik, 34. 2. pp. 185–221, Feb. 3, 1911.)—The method employed in the research was similar to that of Lees [see Abstract No. 1148 (1899)], an electrically heated copper plate being placed between two plates of the substance under investigation, the other faces of the plates being kept at a constant temperature. Thermo-elements were employed to measure the temperature-difference between the two faces of the plates. The substances dealt with were various crystals and amorphous solids. The results of the experiments are given below. (i) *Crystals.*—It is found that the thermal resistance increases in proportion to the absolute temperature, the values for the different crystals dealt with being as follows :—

T.	T/273.	NaCl.	KCl.	CaF_2.	SiO_2 ∥.	SiO_2 ⊥.	$CaCO_3$ ⊥.	$NaClO_3$.	$C_{12}H_{22}O_{11}$.
373°	1·365	60×1·44	60×1·41	40·5×1·29	30·7×1·51	57·8×1·30	97·5×1·21	—	—
273	1·000	1·00	1·00	1·00	1·20	1·00	1·00	374×1·00	720×1·00
195	0·714	0·669	0·670	0·686	0·694	0·719	0·745	0·708	0·740
83	304	0·262	0·333	0·265	0·278	0·295	0·272	—	—

∥ Denotes that the conductivity was measured parallel to, ⊥ that it was measured perpendicular to, the axis.

The absolute value of the conductivity does not seem to depend on the crystal system in any way; it is greater the smaller the number of atoms in the molecule, and is also greater the higher the melting-point. Crystals consisting of diatomic or triatomic molecules have approximately the same conductivity at their respective melting-points (about 0·0048). The behaviour of crystalline substances such as marble, naphthalin, &c., is similar to that of crystals, although the temperature variation, as well as the absolute value of the conductivity is smaller than for crystals. (ii) *Amorphous bodies.*—With these the conductivity increases with rise of temperature. The nature of the temperature variation appears to be similar to that of the specific heat. This seems to signify that the heat conductivity depends on the energy-fall in the substance, an hypothesis which is easy to understand from the standpoint of the Planck-Einstein theory [Abstracts Nos. 1228 (1906) and 489 (1907)]. The conductivity of amorphous bodies is always smaller than that of the corresponding crystals; *e.g.*, at 0° C., the conductivity of quartz glass is 7·5 times, and at —190° C. 55 times smaller than quartz crystal. At the melting-point glass and crystal have about the same conductivity. Some substances, such as paraffin and ebonite, show only a small temperature variation. These are evidently partly crystalline, partly amorphous, and so are of little theoretical interest. A. W.

495. *Singular Heating of Thin Platinum Wire.* **J. A. Le Bel.** (Comptes Rendus, 152. pp. 129–131, Jan. 16, 1911.)—When a coil of thin Pt-wire is placed inside a metallic cylinder of copper or nickel, which is heated electrically or by means of a lead bath, the temperature of the coil rises slightly above that of the cylinder, this difference in temperature being proportional to the temperature of the cylinder up to 500° C., at which it reaches 0·1°. The phenomenon, which is not observed with brass, bronze, or porcelain tubes, is found to depend on the variation of temperature along the tube, but is not proportional thereto. On warming the two ends of the cylinder, while the temperature of the centre remains nearly uniform, no additional rise in temperature of the Pt-wire occurs, but maintaining the copper at 500° for 3 weeks destroys its power of heating the Pt-coil, a power which it does not appreciably regain after 10 days. The effect is not due to vapour given off by the copper, since, when the coil is enclosed in Jena glass or mica, the rise of temperature is only diminished by about one-tenth, and the author concludes that it must be attributed to a radiation, which passes through most metallic laminæ less than 0·5 mm. thick. Palladium behaves very similarly to Pt, but Au is much less active. The thickness of the copper cylinder must be not less than 0·5 mm. to produce the effect; with a thickness of 2 mm. the effect is only half, and with a thickness of 6 mm. it reaches a maximum. The rise in temperature of the Pt-coil has been measured with a le Chatelier differential thermometer. W. H. Si.

496. *New Property of Copper. Convergent Combustion.* **J. Meunier.** (Comptes Rendus, 152. pp. 194–196, Jan. 23, 1911.)—Hot copper-wire, the surface of which has been cleaned by passage through a reducing flame, glows red when introduced into the tube of a Bunsen burner, and gas turned on, the intensity of its incandescence depending only on the air supply. It is preferable to start with a mixture of about 40 per cent. of gas, and then diminish this to 30–33 per cent.; if the air inlet is shut, incandescence disappears, reappearing when air is again allowed to enter, provided the copper is not too cold, but diminishing if the proportion of air is excessive. The author attributes the effect to crystallised copper, and considers that copper which gives it must be electrolytic. [See also Abstracts Nos. 660 (1909), 257, and 945 (1910).]

W. H. Si.

497. *A Constant-temperature Porous Plug Experiment.* **W. A. D. Rudge.** (Cambridge Phil. Soc., Proc. 16. pp. 48–54, Feb. 15, 1911.)—The author describes an experiment for determining the thermal effect of expansion of a gas through a plug. The gas used was CO_2 obtained from a "sparklet" bulb, and the heat absorbed was determined by a Bunsen calorimeter method. The average cooling effected per atmo. difference of pressure was found to be 1·008° C. A. F.

498. *Action of External Forces upon the Tension of Saturated Vapours, and the Gas dissolved in a Liquid.* **G. Lippmann.** (Comptes Rendus, 152. pp. 239–241, Jan. 30, 1911.)—If a volatile liquid, such as water, rises in a capillary tube to a height Δx, the tension of the vapour at the meniscus is necessarily less than the tension at the plane surface. According to Kelvin's theory, this diminution of tension Δf should be expressed by the equation $\Delta f = \phi g \Delta x$, ϕ being the density of the vapour, and g the acceleration due to gravity. Kelvin proposed to explain the difference of tension as follows: The variation Δf is due to curvature of the meniscus: the meniscus exercises a depressing action upon the vapour proportional to the withdrawing action which it exercises upon the liquid. According to this theory, the tension of the vapour will be the same in all parts of the liquid mass, the temperature being supposed uniform, the variation Δf being produced in a discontinuous manner at the curved surface of the meniscus. A new explanation of the phenomena is now proposed, in which it is argued that, on account of the action of gravity, the vapour-tension variation takes place in a continuous manner according to the height of the liquid column. The vapour tension in a liquid mass at uniform temperature ceases to be uniform when the action of gravity renders the system heterogeneous. It is shown that in order for equilibrium to be established, it is necessary that the tension of the dissolved gas should vary with the level according to the same law as the pressure of the gas in the interior of a liquid. A. E. G.

499. *Thermal Molecular Pressure of Gases in Tubes.* **M. Kundsen.** (Ann. d. Physik, 33. 6. pp. 1435–1448, Dec. 20, 1910.)—In the previous papers [see Abstracts Nos. 975 (1909), 665 (1910)] it had been shown that in a tube in which there is a temperature gradient, the gas pressure, at equilibrium, at different points of the tube is different. This theoretical conclusion has now been tested, and the result is that it has been found that at any two points the pressures p_1 and p_2 and the corresponding absolute temperatures T_1 and T_2. When the mean free path of the gas molecules is negligibly small compared with the diam. of the tube, are given by the expression—

$$p_1^2 - p_2^2 = c\,\frac{T_1^2 - T_2^2}{273^2}\ (\text{dynes/cm.}^2)^2.$$

c is a quantity which varies only slightly with changing temperature; it is, however, dependent on the radius of the tube, on the viscosity of the gas, and on the specific gravity of the gas. A. F.

REFERENCES.

500. *Isotherms of Monatomic Gases and of their Binary Mixtures. VI. Coexisting Liquid and Vapour Densities of Argon; Calculation of the Critical Density of Argon.* **C. A. Crommelin.** (Konink. Akad. Wetensch. Amsterdam, Proc. 13. pp. 607–613, Jan. 26, 1911. Communication No. 118a from the Phys. Lab., Leiden.)—By using the value for the critical density 0·509, previously determined, and the values of the density of liquid argon obtained by Baly and Donnan, the author has constructed the graph of the densities of gaseous and liquid argon. A. F.

501. *Isotherms of Monatomic Gases and of their Binary Mixtures. VII. Isotherms of Argon between* +20° C. *and* −150° C. **H. Kamerlingh Onnes** and **C. A. Crommelin.** (Konink. Akad. Wetensch. Amsterdam, Proc. 13. pp. 614–625, Jan. 26, 1911. Communication No. 118b from the Phys. Lab., Leiden.)—The authors have determined the isotherms of argon between the above temperatures and give their results in the form of tables and curves. A. F.

502. *Recent Problems in the Theory of Heat.* **W. Nernst.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 4. pp. 65–90, 1911.)—In this address the author gives a review of some of the recent problems studied and solved, to a partial extent at least, in the domain of thermodynamics, specific heat, and chemical equilibria. It passes in review the essential achievements obtained by the application of the first and second laws of thermodynamics, as well as of the theorem put forward by the author himself, and the work of Planck and Einstein relating to radiation energy and the extension of this to the values of the specific heat of the elements. A warning is also given against the undue extension of the laws of thermodynamics to domains, for which extension no experimental justification has been obtained. The address is of interest as giving a rapid review of a wide field of recent investigation. A. F.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

503. *Atomic Constitution of Electricity.* **F. Ehrenhaft.** (Phys. Zeitschr. 12. pp. 94–104, Feb. 1, 1911.)—Reviews the work of Millikan and of Przibram as to the absolute value of the electronic charge and then describes experiments conducted on the fall and rise of ultramicroscopic particles of silver and of gold which appear to point to a still smaller value of e than that of previous workers, some results with gold favouring the value $e = 1 \times 10^{-10}$ e.s. unit. The view is then put forward that possibly the existence of an indivisible charge of electricity is not yet established. [See Abstracts Nos. 1270 (1909) and 1745 (1910).] E. H. B.

504. *Kaufmann-Simon Determination of* e/m. **K. Lerp.** (Gesell. Wiss. Göttingen, Nachr., Math.-Phys. Klasse, 5. pp. 476–481, 1910.)—A discussion of the sources of possible errors in the Kaufmann-Simon method of determinanation of e/m which gave the value, $1{\cdot}88 \times 10^7$. The repetitions by S. Simon are examined and from the eight values so determined a mean of $1{\cdot}707 \times 10^7$ is derived; or, if reduced to zero velocity by Lorentz's theory, the value e/m_0 in $1{\cdot}72 \times 10^7$. E. H. B.

505. *Separation Mass of Spherical Electrons.* **L. Silberstein.** (Phys. Zeitschr. 12. pp. 87–91, Feb. 1, 1911.)—A glance at the structure of the electromagnetic impulse, from which the two electromagnetic masses may be immediately derived, suffices to show that the total mass of a system of electrons differs from the sum of the masses of the constituents. The difference of these two quantities may be called the *separation mass* (gegenseitige Masse). In the present paper the value of this mass is fully calculated for a system of two spherical electrons with uniform volume charges. The result is expressed by—

$$m_{ij} = \frac{mr}{2a_{ij}}\left(5 - 2\frac{r^2}{a_{ij}^2}\right),$$

where m_{ij} is the mass of the two electrons i and j, r is the radius of either and a_{ij} is their separation distance from centre to centre. E. H. B.

506. *Change in Value of the International Volt.* (Amer. Inst. Elect. Engin., Proc. 30. pp. 343–356, Feb., 1911. Reprint of Circular No. 29 of the Bureau of Standards.)—The paper gives the definitions of the international units of resistance, current, and e.m.f. as laid down at the Chicago Congress, together with a summary of the resulting legislation in various countries. It also gives the units as defined by the London International Conference of 1910, and describes the formation and scope of the International Committee on Electrical Units and Standards. Under the auspices of this committee a joint investigation was conducted at the Bureau of Standards, Washington, by representatives from that Bureau, the National Physical Laboratory, the Reichsanstalt, and the Laboratoire Central, Paris. The first result of this international co-operative work was to show that the e.m.f. of the Weston

normal cell is, within 1 part in 10,000, 1·0183 int. volts at 20° C., and the international committee recommend the universal adoption of this value. Accordingly on Jan. 1, 1911, the Bureau of Standards will adopt 1·01830 int. volts at 20° C. as the value for the e.m.f. of the cell. The following values have been in use up to the present time—

In the United States	1·019126	int. volts at 20° C.
In Germany	1·0186	„ „
In Great Britain.............................	1·0184	„ „

[NOTE BY ABSTRACTOR.—On Jan. 1, 1911, the National Physical Laboratory and the Reichsanstalt formally adopted the value 1·0183 int. volts at 20° C. for the cell.] F. E. S.

507. *Electric Stresses from the Mechanical Point of View.* **W. S. Franklin.** (Frank. Inst., Journ. 171. pp. 245–259, March, 1911.)—In this paper the author discusses the electric stress, making the assumptions that the electric breakdown occurs at a definite electric field intensity and that the line of discharge is a conducting path. Effects involving time, such as fatigue effects, the peculiar characteristics of very short air-gaps, the corona discharge, &c., will be discussed in a later paper. An electric and magnetic analogy is elaborated. Electric field intensity (stress) is expressed in volts per cm., but electric flux-density (strain) is expressed in coulombs per cm.^{2}. The effects produced when the dielectric coefficients of the insulating materials between the electrodes are different are explained and mechanical analogies developed. The hysteresis of dielectrics is explained. The most prominent kind is one that is closely analogous to elastic lag in mechanics. Glass, for instance, when subjected to mechanical stress is strained quickly to a certain extent. This strain slowly increases with time, and when the stress is removed the strain persists for an appreciable time. This kind of hysteresis is called viscous hysteresis. It is very different from the ordinary hysteresis of iron or steel. The effect of the concentration of the electric stress by points is explained by instructive mechanical analogies. A. R.

DISCHARGE AND OSCILLATIONS.

508. *Connection between Chemical Affinity and Photo-electric Effects in Compounds of Potassium.* **R. Pohl** and **P. Pringsheim.** (Deutsch. Phys. Gesell., Verh. 12. 23. pp. 1039–1048, Dec. 15, 1910.)—As the result of experiments here described, it is found that the limits of the normal photoelectric effects are displaced when potassium is in combination with another metal. The displacement is so much the greater towards the shorter wave-lengths the more electro-negative the second component of the alloy. If a selective effect is present it is displaced so much further towards the ultra-violet and at the same time is so much the more strongly damped the more electro-negative the second component of the alloy. It seems quite probable that a series of tensions for the affinity between electrons and metals can be defined by means of the photoelectric effects. A. E. G.

509. *Existence of a Periodic Element in the Magneto-kathode Rays.* **Gouy.** (Comptes Rendus, 152. pp. 241–242, Jan. 30, 1911.)—The magneto-kathode rays emitted by a wire kathode form a luminous sheet, separated from the kathode by a darker interval. In favourable circumstances dark and bright fringes can be distinguished in this bright part. These fringes present a most remarkable character: when the intensity of the magnetic field is varied they are displaced regularly in succession, moving with unequal velocity so that they close up when the field is increased. The essential element in the production of fringes in nearly uniform fields is the length of the magneto-kathode rays measured on the lines of force from the kathode to the obstacle in which the rays terminate. The maxima of intensity correspond to rays of which the lengths are exact multiples of a certain length *a*, which is inversely proportional to the value of the magnetic field. The length *a* does not depend solely upon the magnetic field, it increases very nearly in proportion to the square root of the voltage. The phenomena described indicate that a periodic element exists in the magneto-kathode rays. A. E. G.

510. *Production of Light by Canal Rays.* **G. S. Fulcher.** (Astrophys. Journ. 33. pp. 28-57, Jan., 1911.)—In order to reconcile the simultaneous electrostatic and magnetic deflection of the rays with the Doppler-effect it is assumed that the sources of light showing this effect are the gas molecules hit and ionised by the canal rays, rather than the canal rays themselves. If this is so, then the intensity of light from a canal-ray beam should vary directly as the number of collisions per unit time per unit length of their path. An experiment is described from the results of which it is concluded that this is exactly what takes place. It further appears that the mean intensity of light emitted per collision is proportional to the mean energy of the individual rays, that is, to the mean energy of each collision. As the result of calculation it is suggested that if the neutral rays produce ionisation the minimum energy required must be considerably greater than is necessary in the case of charged rays, so that the light thus produced is insignificant. The hitting charged rays must be neutralised for the most part, and particularly when the shock of collision is great, at the same instant the hit molecule is ionised. If this is correct, then the series-line spectrum of hydrogen, which alone shows the Stark-effect, is emitted by the positively-charged molecule or atom of hydrogen. A discussion of the results obtained by Strasser [see Abstract No. 905 (1910)] is given. W. Wien has also found that the luminosity of the canal-ray beam increases with the pressure, but his interpretation of the results is different from that here given. [See Abstract No. 2100 (1909).] A. E. G.

511. *New Method of Investigating the Positive Rays.* **J. J. Thomson.** (Cambridge Phil. Soc., Proc. 16. p. 120, Feb. 15, 1911.)—In this method the rays are received on a photographic plate which is inside the discharge tube and placed in a light-tight case until it is wished to photograph the rays, when the plate is lifted from its case by a mechanism worked from outside and the rays are allowed to fall upon it. It is found that a photographic plate is very sensitive to the rays; a pencil of these only ⅓ mm. in diam. gives a good photograph in less than 5 min. By this means a permanent record can be obtained, and greater accuracy of measurement ensured. Using this method, positive rays of a secondary nature are now shown to be present in addition to the atoms and molecules described in a previous paper [Abstract No. 121 (1911)]. These secondary rays have values of m/e 1·5, 2·5, &c. that for the hydrogen atom. A. E. G.

512. *Mean Depth at which Röntgen Rays originate within a Silver Antikathode.* **W. P. Davey.** (Frank. Inst., Journ. 171. pp. 277-285, March,

1911.)—The Röntgen-ray bulb used is in the form of a bell-jar of 7 cm. radius and 16 cm. height. The flange is accurately ground to a plane surface and fitted to a thick plane glass plate. Three holes, each 2 cm. diam., are drilled into the side of the jar at a height of 10 cm. above the flange in such a way that the angular distance along the cylindrical surface of the bell-jar from the centre of one hole to the centre of the next is 80°. Into the central hole is cemented a funnel-shaped tube which holds the kathode. Short glass cylinders are ground into the other two holes. Each of these carries a small glass window cut from the same sheet of glass. The antikathode is pivoted on an upright post at the centre of the bell-jar, so that it can be placed at any desired angle to the kathode rays. The position chosen is such that the normal to the antikathode passes through one of the windows. By this arrangement the rays generated in the silver plate used as antikathode have to pass through different thicknesses of silver before proceeding through the windows to the electroscopes which are used to measure the effects produced. As the result of the experiments it is concluded that the mean depth at which the Röntgen rays originate in a silver antikathode is directly proportional to the potential employed in generating the rays. A. E. G.

513. *The Afterglow of Electric Discharge.* **R. J. Strutt.** (Phys. Soc., Proc. 23. pp. 66–78; Discussion, p. 78, Dec., 1910.)—In studying the afterglow which occurs in vacuum tubes containing particular gaseous mixtures a method originally due to Dewar is used. A powerful air-pump is employed to draw a regulated current of gas through the vacuum tube. In this way a continuous removal of the gas from the region of discharge is effected, and the afterglow which it emits in passing through another vessel on its way to the pump can be examined continuously and at leisure. With pure oxygen the glow obtained, if any, is exceedingly faint; with air, on the other hand, a bright yellow glow is obtained, and this is improved by enriching the air with oxygen. Pure nitrogen gives no glow whatever. The glow from air is not appreciably affected by drying the air or by saturating it with moisture. Experiments are described which lead to the conclusion that the afterglow is the result of three distinct processes: (*a*) the formation of ozone in the discharge; (*b*) the formation of nitric oxide in the discharge; and (*c*) the oxidation of nitric oxide by the ozone after the discharge is over. A. E. G.

514. *Electrical Discharge.* **F. E. Nipher.** (Science, 33. pp. 151–153, Jan. 27, 1911.)—In a former paper it was suggested that the striæ in a vacuum tube were of the nature of waves in an organ-pipe. This led to the idea of imposing resonance vibrations on a column of air contained in a glass tube, which also had terminals connected to an influence machine. The air vibrations were produced by a blast of air from a pressure tank directed across the mouth of another tube. It is found that with very careful adjustments the electric discharge across a small gap in the glass tube could be affected in a marked way by the impressed sound waves. A luminous discharge was apparently converted into a dark discharge. Attempts are being made to sound an organ-pipe by periodically varying electrical stresses in the air column. [See Abstract No. 288 (1911).] E. H. B.

515. *Stationary Electric Waves.* **M. Hammer.** (Deutsch. Phys. Gesell., Verh. 13. 1. pp. 27–52, Jan. 30, 1911.)—The object of the investigation is to redetermine, by means of stationary waves, the velocity of propagation of electric waves in air and along wires in order to see if a closer agreement in

these velocities can be attained by experiment. The same ring-resonators are used to determine the wave-length in air and the wave-length along wires. The results give a velocity in air from 1 to 1·5 per cent. greater than the velocity along wires. The wave-length as measured in air comes out larger when the reflecting surface is made smaller. (*Corrigendum*, p. 180.)

T. P. B.

516. *Electric Dispersion of Water and Ethyl Alcohol for very Short Waves.* **H. Merczyng.** (Acad. Sci. Cracovie, Bull. 2a. pp. 123–128, Feb., 1911.)—Continuing previous work, it is now found that the index of refraction of water is $n = 6{\cdot}44$ to electric waves of length 8·5 cm. and frequency $3{\cdot}56 \times 10^9$; the corresponding dielectric constant being $n = 41{\cdot}5$, whereas for very long waves $n^2 = 80$. [See Abstracts Nos. 139 and 1627 (1910).] E. H. B.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

517. *Dielectric Constants of the Halogen Compounds of Lead.* **A. Lenert.** (Deutsch. Phys. Gesell., Verh. 12. 24. pp. 1051–1058, Dec. 30, 1910.)—The dielectric constants of the lead haloids are as follows: $PbCl_2$, 4·20; $PbBr_2$, 4·89; PbI_2, 2·85; PbF_2, 3·62. Exact results can be obtained only with pure substances. A. F.

518. *Electrical Properties of Aluminium-Magnesium Alloys.* **W. Broniewski.** (Comptes Rendus, 152. pp. 85–87, Jan. 9, 1911.)—Previous studies of this system of alloys have given very discordant results, different observers having found evidence for the existence of the compounds Al_4Mg, $AlMg$, $AlMg_2$ and Al_3Mg_2 or Al_3Mg_4. The author has therefore studied the electrical conductivity, the temperature coefficient of resistance between 0 and 100° C., the e.m.f. generated against lead and the electrolytic solution tension in a solution of ammonium chloride of these alloys with a view to elucidating their constitution. Plotted as functions of the volume concentration, the results reveal the existence of the two compounds, $AlMg$ and Al_3Mg_2, which form solid solutions with each other, rendering their investigation by thermal analysis very difficult. The non-existence of compounds corresponding to the formulæ Al_4Mg and $AlMg_2$ has been confirmed by microscopic examination of alloys corresponding to these compositions, both of which showed a distinctly heterogeneous structure. F. C. A. H. L.

519. *Change of Resistance of Nickel in the Magnetic Field.* **E. A. Owen.** (Phil. Mag. 21. pp. 122–130, Jan., 1911.)—The change of resistance of nickel in magnetic fields of various strengths was measured by means of a slide-wire bridge, precautions being taken to avoid errors due to heating of the bridge wire or its connections. The nickel used consisted of very thin straight wires only about 1 mm. long placed longitudinally in the narrow gap between the pole-faces of an electromagnet. It was found that in each experiment there was a decided max. change of resistance followed by a diminution in stronger fields. With a nickel wire of diam. 0·0206 mm. the max. value of $\Delta\phi$, the fractional change of resistance, was 0·01462 in a field, H, of 2800 c.g.s. units. With a nickel wire of diam. 0·0159 mm. the max. value of $\Delta\phi$ was 0·01418, when H was 2800 c.g.s. units. Iron wire, diam. 0·0208 mm. had max. $\Delta\phi$ 0·00222 with H 1900 c.g.s. units. In the case of nickel the change of resistance shows a tendency towards a constant minimum which is reached in a field of about 24,000 c.g.s. units. For the first specimen the total decrease

in the value of $\Delta\phi$ after the maximum is reached is 0·0080 and for the second specimen 0·0042. There is no tendency towards a constant minimum shown in iron in the fields examined, the fractional change of resistance steadily diminishing as the magnetic field increases. J. J. S.

520. *The Thomson-effect and its Variation with Temperature.* **P. Cermak.** (Ann. d. Physik, 33. 6. pp. 1195–1215, Dec. 20, 1910.)—The object of the research described was a determination of the Thomson-effect and its dependence on temperature in the case of the metals Hg, Pb, Sn, Zn, Cd, and Al; these metals being chosen because they exhibit a somewhat small Thomson-effect and because the author has measured the thermo-e.m.f. and the Peltier-effect for most of those metals within almost the same temperature interval. [See Abstracts Nos. 125 and 1475 (1908).] The observation of Battelli that lead has a distinct though small Thomson-effect is confirmed. For the six metals named the Thomson-effect was measured within a range of 350° C. The results which are shown on a curve indicate that there is an increase, as a rule, with rise of temperature which the hypothesis of Tait, $\sigma = a\theta$ (σ Thomson-effect, θ abs. temp.) does not express. The effect is very small in Pb, Sn, and Al but in *no* metal is it quite zero. On passing over from the solid to the liquid condition the curves showing the Thomson-effect keep a continuous course, whilst at the same time the resistance curves show a lack of continuity. J. J. S.

521. *Formula for the Self-inductance of a Long Coil wound with any Number of Layers.* **F. L. Bergansius.** (Konink. Akad. Wetensch. Amsterdam, Proc. 13. pp. 917-927, March 28, 1911.)—The author states that no very accurate formula has yet been given for the self-inductance of a long coil having many layers. L. Cohen only claims a moderate accuracy for his formula (which the author says contains two errors), when the length of the coil is twice the diam. The author also criticises the method of Rosa, saying that it will make the self-inductance too small. In the particular case of a single-layer coil the formula given by the author is stated to be in close agreement with Lorenz's formula. It has to be remembered, however, that the Lorenz formula is for a cylindrical current sheet and that simple expressions for it in various cases have previously been found. A. R.

522. *Experiments with a* 10,000-*volt Storage Battery.* **A. A. C. Swinton.** (Electrician, 66. pp. 863–864, March 10, 1911. Abstract of paper read before the Röntgen Soc.)—At the suggestion of W. Crookes this storage battery was made to test the effect of using a continuous battery current in high-vacua discharges. The battery consists of 4800 cells, and so divides conveniently into sections of 80 cells each, right for charging in parallel off the 200-volt supply. Then, on putting in series, the battery gives 10,400 volts on open circuit. Each cell consists of a glass test-tube 4 in. long and ¾ in. bore, and each set of 40 cells is cast solid with paraffin wax into a wooden tray. The battery is of the Planté type, and the plates, which are not pasted, are made of sheet lead cut off into strips in a machine similar to that used for trimming photographs. Each strip is further bent round a shaped piece of wood and pressed in a hand press, with the result that the lead is given a corrugated form which is not so liable to deformation. These plates are put into the test-tubes with dilute sulphuric acid, and kept from touching each other by means of celluloid separators. All the plates were originally formed in a nursery battery before

being transferred to the battery proper. The total weight of lead in each of the five sections (of 960 cells each) is about 80 lbs., or 400 lbs. for the whole battery, whose total weight is about 1000 lbs. To avoid bubbling of the acid it has been found best to charge the battery at a rate not exceeding 10 milliamps. To this low rate of charging and to the paraffin wax is ascribed the fact that the surfaces keep quite dry, and that the battery has an excellent insulation and keeps its charge very well. The battery is capable of discharging at a rate of 150 milliamps. for several minutes, which means a discharge capacity of 1½ kw. The internal resistance varies (with the current) between 3000 and 4000 ohms. The battery is provided with a double-pole main switch and water resistance, each operated by cords to avoid the dangerous shock otherwise possible. Between polished brass balls 12·5 mm. diam. the current jumped about 2·5 mm., and the resultant arc could be drawn out to a considerable length. The current is not always entirely continuous, for the arc often gives a whistling sound. With a Leyden jar, the arc gives a musical note. The usual vacuum-tube discharges can also be obtained with the battery. E. H. B.

523. *Clark and Weston Standard Cells.* **H. L. Bronson** and **A. N. Shaw.** (Electrician, 66. pp. 698–701 and 701–702, Feb. 10, 1911. Paper read before the British Assoc. at Winnipeg, 1909, with note added in Oct., 1910.)—The object was to test the constancy and reproducibility of Clark and Weston cells. New cells set up by the authors were compared with others set up by Wolff and Waters [see Abstract No. 122 (1908)] and also with some cells set up at the National Physical Laboratory. An examination of the results shows that the mean e.m.f. of the Clark cells set up differs from the mean of the reference cells by less than 15 microvolts and of 16 cells the average deviation from the mean is 18 microvolts. In the case of the Weston cells the mean difference from the reference cells is 10 microvolts and the average deviation from the mean is also about 10 microvolts. The purification of the zinc and cadmium sulphates was found to be not of great importance and an excess of basic oxide in the sulphate is believed to have an inappreciable influence on the e.m.f. The importance of purity in the mercurous sulphate is emphasised. The ratio of the Clark to the Weston cell was determined to be 0·716958 at 25° and agrees with the ratio obtained by Wolff and Waters. The final conclusion is that the Weston cell is more satisfactory than the Clark. F. E. S.

524. *New Type of Arc Lamp with Mercury Kathode and White Light.* **E. Urbain, C. Scal,** and **A. Feige.** (Comptes Rendus, 152. pp. 255–256, Jan. 30, 1911.)—In the ordinary mercury-vapour lamp with anode of iron the distance between kathode and anode is relatively great; the tube radiates energy throughout its entire length, the mercury vapour becomes luminescent and the anode remains cold. In the new lamp the anode is made of tungsten and placed at a much smaller distance (5 mm.) from the mercury kathode in an inert gas or *in vacuo*. Under these conditions the mercury plays no part, except in facilitating the lighting, as an arc is formed. The tungsten is raised to incandescence and the transport of the metal which constitutes the positive electrode, to the negative pole is not noticeable, which is necessary from the point of view of duration. The spectrum of this new luminous source consists of a continuous spectrum on which are superposed the rays due to mercury. In the continuous spectrum the very intense blue is still reinforced by mercury rays so that the whole tone of the spectrum approaches that of sunlight. A suitable intense source of white light which by the use of quartz envelope can be employed as a very economical source of ultra-violet light, is thus obtained. A. E. G.

ALTERNATING CURRENTS AND MAGNETISM.

525. *Magnetic Permeability of Iron in Low Fields.* **E. Gumlich** and **W. Rogowski.** (Ann. d. Physik, 34. 2. pp. 235–257, Feb. 8, 1911. Communication from the Physikal.-Techn. Reichsanstalt. Elektrotechn. Zeitschr. 32. pp. 180–184, Feb. 23, 1911.)—A series of magnetic tests have been carried out on several varieties of iron by the yoke method, the materials being tested in both the unannealed and annealed conditions and in applied fields up to 0·4 c.g.s. units. The following are some of the varieties of iron tested, with the initial value of the permeability of each in the annealed condition :—

Material.	Initial Permeability.
Swedish soft iron (0·027 C per cent.)	470
Dynamo-steel (0·40 Mn, 0·04 C per cent.)	490
Dynamo-steel (0·38 Mn, 0·085 C per cent.)	158
Carbon steel (0·99 C per cent.)	72·8
Cast iron (3·1 C, 3·3 Si, 1 P per cent.)	176
Silicon steel (0·48 Si, 0·14 C per cent.)	158
Silicon steel (1·98 Si, 0·16 C per cent.)	228
Silicon steel (4·45 Si, 0·29 C per cent.)	510
Electrolytic iron, forged, unannealed	250

The annealing process consisted in heating the metal for 24 hours at 800° C. in a vacuum and thence cooling slowly back to room temperature. In general, annealing resulted in a decided increase in the initial permeability—an increase of as much as 160 per cent. in the case of cast iron—but in a few cases, such as carbon steel and low-Si irons, there was a diminution in the permeability. The tests carried out by the authors do not confirm the view that with such small applied fields as $H < 0·02$, iron shows no residual magnetisation. On the contrary they find a residual of about 7 to 8 per cent. of the temporarily induced magnetisation. A. D. R.

526. *New Method of Determining Permeability of Gases.* **W. P. Roop.** (Phys. Zeitschr. 12. pp. 48–56, Jan. 15, 1911.)—The method consists in measuring the velocity and deflection of path of a stream of the gas led between the poles of a strong electromagnet. The theory of the method is worked out and an expression is found for the difference of permeability of the gas and the medium into which it flows. The pole-pieces employed were one wedge-shaped and the other flat, and the gas emerged from a nozzle in line with the edge of the wedge. For additional details the original paper should be consulted. Four series of determinations with CO_2 gave, for $\mu(CO_2) - \mu(\text{air})$, $0·0885 \times 10^{-6}$, and for the difference in susceptibility $0·0260 \times 10^{-6}$. It is considered justifiable to take $\kappa = 0$ for the susceptibility of CO_2. [See also Abstracts Nos. 1449 (1905) and 486 (1908).] G. E. A.

527. *Magnetic Properties of Flames.* **W. P. Roop.** (Phys. Zeitschr. 12. p. 56, Jan. 15, 1911.)—Employing a method similar to that described in the preceding Abstract, the behaviour of a long, thin, coal-gas flame was found to resemble that of a current of CO_2. As the latter is diamagnetic only in

comparison with air, this is suggested as being the case with flames also. This view was strengthened by the fact that a reversed flame of air in coal-gas showed no trace of diamagnetism. G. E. A.

528. *Molecular Magnets.* **P. Weiss.** (Comptes Rendus, 152. pp. 79–81, Jan. 9, 1911.)—It is shown by the theory of the molecular field, and also by experiment, that at temperatures above that of disappearance of strong magnetism the reciprocal of the saturation value of specific magnetisation varies linearly with the excess of the temperature above the critical value. We can deduce from the relation between these two quantities a number which is the magnetic moment of the molecule multiplied by a factor. This factor is known if we know the number of degrees of freedom of rotation of the molecule, and it must be a small-quantity integer for the comparatively simple molecules of the ferromagnetic materials. Tests carried out on magnetite have shown that the curve obtained by plotting the reciprocals of saturation specific magnetisations against the corresponding temperatures contains five straight lines, which characterise five conditions of the magnetite. If we postulate a molecule of fixed mass and form, preserving the same number of degrees of freedom, we can calculate the value of the saturation specific magnetisation at absolute zero from data for any one of these five conditions. The five resultant values are in the ratios 4 : 5 : 6 : 8 : 10. The conclusion is drawn that the magnetic moment of the molecule increases suddenly at definite temperatures by a quantity which is either a quarter or half the value of the magnetic moment at —273° C. The increase may be due to change either in the pole strength or in the polar separation. If we assume the molecule Fe_3O_4 to possess four degrees of freedom of rotation, the saturation value of the specific magnetisation at absolute zero as deduced from experiments carried out between temperatures 580° and 625° C. is found to be 97·7, which is very near the value 95·9 found by Onnes and Weiss for magnetite at the temperature of liquid hydrogen. A. D. R.

529. *New Constituent of Magnetic Materials.* **P. Weiss.** (Comptes Rendus, 152. pp. 187–189, Jan. 23, 1911.)—The author, by tests on magnetite at temperatures ranging from 580° to 1850° C., derived, on certain assumptions, five values for the saturation specific magnetisation at absolute zero. These values were in the ratios 4 : 5 : 6 : 8 : 10 [see preceding Abstract]. From this fact and from values obtained for solutions of salts of Fe, Ni, Co, Cu, Mn, and Ur, the author is led to postulate the existence of a common constituent of magnetic materials—the elementary magnets of which he terms *magnétons*, and which are to be found in the atoms of all magnetic substances.

A. D. R.

530. *Variation of Magnetic Hysteresis with Temperature.* **A. Perrier.** (Journ. de Physique, 9. pp. 785–819, Oct., and pp. 865–887, Nov., 1910. Paper read before the Soc. franç. de Physique, July 1, 1910.)—The author describes an extensive series of investigations of the variation with temperature of hysteresis is rotating and alternating fields. After describing the apparatus employed and the precautions adopted, he gives results obtained in the case of nickel, iron, and artificial magnetite. He finds in general a close relationship between alternating and rotational hysteresis. The elementary coercive field H_e can also be written $H_e = \phi(\theta)$, and obeys closely the law $I = f(\theta)$ over a wide range of temperature. These two relationships are not directly deducible the one from the other, but they are, nevertheless,

interdependent. In his work the author has, instead of using, as is common, magnetisations in constant fields, employed homologous magnetic intensities. This novel idea, which is analogous to that of corresponding states in the theory of fluids, permits of the numerical results being readily grouped together. It allows us, in particular, to speak more precisely of a law of variation with temperature, and it is applicable not only to hysteresis curves, but also to magnetisation curves. A. D. R.

531. *Ferromagnetic Bodies at Temperatures above the Curie Point.* **P. Weiss** and **G. Foëx.** (Archives des Sciences, 31. pp. 5–19, Jan., and pp. 89–117, Feb., 1911.)—At temperatures above that at which ferromagnetism disappears the specific susceptibility χ multiplied by the excess of temperature above the critical temperature is constant, or $\chi(T-\theta)=C$. Experiments were made on the magnetic metals and on magnetite, pyrrhotine and a series of ferro-nickels, to test the limit of validity of the above theory. Curie's method was followed. Three specimens of artificial magnetite prepared at high temperature were tested over the range 580° to 900°, in which the behaviour of magnetite was characterised by four different states. For an ellipsoidal specimen of pure Ni it was found that the magnetic properties of this metal were constant between 400° and 1100°. In iron the discontinuities at 920° and 1395° separate the β, γ, and δ regions, and the measurements in these regions confirm, in the main, Curie's results. From the results for the ferro-nickels it is concluded that in a solid solution of two magnetic metals the Curie constant is additive. G. E. A.

532. *On Magnetic Testing.* **J. G. Gray** and **A. D. Ross.** (Phil. Mag. 21. pp. 1–11, Jan., 1911.)—The authors have discovered that purely thermal treatment such as that involved in annealing a specimen, no matter what temperature is reached in the process, develops in the specimen a peculiar state which makes additional precautions imperative. It is proved that an alteration of temperature produces a "sensitive state" of the material. A magnetisation curve obtained from the specimen after any change or cycle of changes in the temperature is not the true magnetisation curve of the material. Once a specimen is made magnetically "neutral" it remains neutral, provided that the temperature remains constant. The "sensitive state" cannot be induced by prolonged exposure of the specimen either to high or low temperatures; it is brought on in the process of heating or cooling it. Experimental results are given showing the effects of varying the temperature of the specimen from —190° C. to 900° C. A. R.

533. *Hall-effect in Alloys.* **A. W. Smith.** (Phys. Rev. 32. pp. 178–200, Feb., 1911.)—Alloys of Sb with Bi, Cd, Zn, in varying proportions, are made, and plates of these are tested for the Hall-effect, the Nernst-effect, the thermo-electric heights, and the temperature coefficient of resistance. Curves are plotted connecting these effects with the percentage constitution of the alloy. It is found that in the case of Sb-Cd and Sb-Zn alloys each of these curves has a singular point where the metals are present in the ratio of their atomic weights, *i.e.*, corresponding to compounds SbCd and SbZn. But in the case of Sb-Bi alloys there is no singular point, though a maximum is observed at 10 per cent. Sb and 90 per cent. Bi. The change of resistance of the Sb-Bi alloys in a magnetic field is also studied, and it is shown that the change in resistance decreases very rapidly with increasing amounts of Sb present. [See also Abstracts Nos. 804, 1186 (1907), and 851 (1910).] T. P. B.

534. *Heusler Magnetic Alloys.* **A. A. Knowlton.** (Phys. Rev. 32. pp. 54–68, Feb., 1911.)—A number of Cu-Mn-Al alloys were prepared and tested by the magnetometric method. The alloys were formed by the addition of Al to a Cu-Mn melt, and the bath was cast and remelted several times to ensure a uniform mixture. The metal was contained in silica-free graphite crucibles, and no flux was employed, as its use was found to result in the metal eating rapidly into the crucible. The alloy was kept for a prolonged time in the molten condition, then poured into hot moulds, and when the temperature had fallen after an hour to about 250° C., the casting was quenched by immersion in hot water. Specimens prepared in this way were of good mechanical quality, free from flaws, and in many cases malleable to a considerable degree. Annealing at 160° improved the magnetic quality, while a subsequent annealing at 250° greatly diminished the permeability. The magnetic property was, however, partially restored by a further annealing at a temperature of over 300° C., as was found by Ross and Gray [see Abstract No. 1308 (1909)]. Examination of the microstructure of polished sections etched with ferric chloride showed three varieties of crystals—white, dark grey, and black. The percentage area covered by the white crystals is approximately proportional to the saturation intensity of magnetisation, and the author concludes that these white crystals contain molecular groupings which are capable of becoming magnetic under proper conditions of temperature. A. D. R.

535. *Ageing of Heusler Magnetic Alloys.* **E. Take.** (Deutsch. Phys. Gesell., Verh. 12. 24. pp. 1059–1084, Dec. 30, 1910.)—The author has investigated the effect of baking at moderate temperatures Heusler alloys which had been quenched, in order to reduce the hysteresis loss. Exposure of the quenched alloy to a temperature of about 209° C. resulted in the highest susceptibility for low fields being attained in about 4 hours. The higher the testing field the longer should the alloy be baked in order to give the material the highest possible susceptibility. From a consideration of the effect of ageing on the susceptibility and on the critical temperature of Cu-Mn-Al alloys, the author seeks to adduce evidence in support of Heusler's theory that the carriers of the magnetism in these bronzes are compounds $(\mathrm{AlM}_3)_n$, where M stands partly for Mn and partly for Cu atoms. A. D. R.

REFERENCES.

536. *Electric Charge on Nuclei.* **E. Regener.** (Phys. Zeitschr. 12. pp. 135–141, Feb. 15, 1910.)—Reviews the various determinations and adds a description of new experimental research leading to the value $4{\cdot}90 \times 10^{-10}$ e.s. unit, which lies near Millikan's determination. [See Abstracts Nos. 1471, 1745 (1910)], and 282 (1911).] E. H. B.

537. *Number of Vibrators in Vapours, Solutions, and Luminous Gases.* **J. Koenigsberger.** (Phys. Zeitschr. 12. pp. 1–5, Jan. 1, 1911.)—A continuation of previous work [see Abstract No. 1301 (1910)]. The number of vibrators can be determined from the absorption and dispersion of electromagnetic radiation in a substance, and a method is described for obtaining the absorption. G. E. A.

538. *Reflection of Electromagnetic Radiation.* **H. T. Wolff.** (Ann d. Physik, 33. 6. pp. 1227–1238, Dec. 20, 1910. Extract of Dissertation, Rostock, 1910.)—A mathematical treatment of reflection and transmission on the electromagnetic theory. E. H. B.

539. *Statistical Treatment of a Resonator in a Field of Radiation.* **A. Einstein and L. Hopf.** (Ann. d. Physik, 33. 6. pp. 1105–1115, Dec. 20, 1910.)—An endeavour to obtain on the electromagnetic theory a result which accords with experiment. The discussion, however, leads to the well-known Rayleigh-Jeans law of radiation which is in striking contradiction to experience. E. H. B.

540. *Direct Dispersion of Canal Rays.* **J. Koenigsberger and J. Kutschewski.** (Deutsch. Phys. Gesell., Verh. 13. 4. pp. 151–158, Feb. 28, 1911.)—By the method adopted strong dispersion is obtained with very small deviations, and use is made of the photographic action of the rays to obtain records of the results produced by electrostatic and magnetic fields upon the canal rays. [See also Abstracts Nos. 154 and 155 (1911).] A. E. G.

541. *Discharge Potential in the Magnetic Field.* **E. Bloch.** (Comptes Rendus, 152. pp. 191–193, Jan. 23, 1911.)—In two recent papers [see Abstracts Nos. 1125 (1910), 265 (1911)] Gouy has sought to explain the marked lowering of potential when a magnetic field acts by interkathodic action. The experiments described in this paper tend to show that the modern theory of the disruptive discharge is quite sufficient to explain all the phenomena observed, and it would seem in certain cases that the explanation offered by Gouy is at fault. A. E. G.

542. *Mutual Inductance of Coaxial Solenoids.* **G. R. Olshausen.** (Phys. Rev. 31. pp. 617–636, Dec., 1910.)—The author discusses Cohen's and Nagaoka's formulæ [see Abstracts Nos. 1401 (1907) and 272 (1908)] for the mutual inductance of two cylindrical current sheets. Cohen's result is given in Legendre's elliptic integrals and Nagaoka's in Weierstrassian functions. The author deduces a general expression from which both Cohen's and Nagaoka's results can be obtained. A. R.

543. *High-voltage Battery.* **H. Hörig.** (Phys. Zeitschr. 11. pp. 1222–1226, Dec. 15, 1910.)—The author describes a 1750-volt apparatus consisting of 20 batteries, each of 121 copper-water-zinc cells for use in work with the electrometer [see Abstract No. 1297 (1908)]. Diagrams are given of the fittings and methods of securing satisfactory insulation, and particulars are supplied as to the effect of temperature, short-circuiting, &c., on the e.m.f. A. D. R.

544. *Thermoelectric Peculiarities of Alloys.* **W. Broniewski.** (Rev. de Métallurgie, 7. p. 341, 1910, Metallurgie, 7. pp. 673–683, Nov. 8, 1910.)—The author in his study of the thermoelectric behaviour of alloys has compared it with the structure of these alloys as established by other methods. He has brought together in an interesting summary the results of numerous investigators. J. J. S.

545. *Metallic Conductors of High Resistance.* **H. v. Martin.** (Phys. Zeitschr. 12. pp. 41–48, Jan. 15, 1911.)—An account of a series of observations made on the resistance, its change with temperature, and other properties of certain crystalline substances of high resistance. The substances do not exhibit sure signs of electrolytic conduction, but their heats of dissociation have a magnitude which classes them on the border between metallic and electrolytic conductors. G. E. A.

546. *Magnetic Permeability.* **R. Gans.** (Ann. d. Physik, 33. 6. pp. 1065–1095, Dec. 20, 1910.)—The paper deals in greater detail with the "reversible permeability" and "reversible susceptibility" of magnetic materials which were discussed in a previous communication [see Abstract No. 147 (1911)]. Tables of results are given for soft iron, nickel, and Remy magnet steel. A. D. R.

547. *Spark Inductors and Röntgen Tubes.* **F. Dessauer.** (Phys. Zeitschr. 12. pp. 14–17, Jan. 1, 1911.)—The physical aspect of the following two points are considered: (*a*) The method of obtaining a radiograph of the human trunk with a single discharge through the Röntgen tube. (*b*) The method of obtaining the best results from a Röntgen tube when the rays are employed in the treatment of skin diseases, ulcers, &c. A. E. G.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

548. *Chemical Investigation of the Actinium-containing Residue in the Production of Radium.* **C. A. v. Welsbach.** (Akad. Wiss. Wien, Sitz. Ber. 119. 2a. pp. 1011–1054, June, 1910. Communication from the Radium Commission of the Academy. Zeitschr. Anorg. Chem. 69. 4. pp. 353–391, Feb. 22, 1911.)—The substance investigated consisted of 2000 kg. of precipitate formed by adding NH_4OH to the HCl filtrate of 10 tons of pitchblende. The author finds this to contain, apart from polonium, two principal radio-active substances, ionium and actinium. The ionium obeys all the reactions of Th, while the Ac comes between La and Ca. The richest ionium preparations which the author succeeded in separating from the Th contained 2¼ per cent. ionium, while the Ac preparations were not determined. E. M.

549. *The Adsorption of Gases by Charcoal.* **A. Titoff.** (Zeitschr. Phys. Chem. 74. 6. pp. 641–678, 1910.)—Notwithstanding numerous investigations of the adsorption of gases by solid bodies, it is difficult to put forward general rules in connection therewith. One of the reasons for this is that the substances which possess the greatest adsorbing power are, for the most part, not definite chemical individuals, and consequently an absolute value cannot be ascribed to the results obtained by different investigators. Another, and chief, reason is that there are no investigations in which the effect of temperature on the adsorption, and also the heat of adsorption were measured under similar conditions. In order to fill up this gap the adsorption of hydrogen, nitrogen, carbon dioxide, and ammonia by cocoanut charcoal has been measured at temperatures between −79° and 151·5°. By means of numerous control experiments it was shown that the process of adsorption is reproducible. In the case of hydrogen Henry's distribution law holds, the adsorbed quantities of gas being proportional to the pressure at constant temperature. For the three other gases, at constant temperature, the relation holds: $a_t = \alpha p_t^{1/n}$, where a_t is the quantity of gas adsorbed, p_t is the pressure, and α and $1/n$ are constant. This relation demands that in the $\log a - \log p$ diagram the isothermals should be straight lines, whilst as a matter of fact at low temperatures they are slightly concave to the $\log p$ axis. At 151·5° the values of $1/n$ and α are respectively 0·976 and 0·01788 for nitrogen; at 80° the values are 0·9284 and 0·05687 respectively, and the calculated results agree well with the experimental numbers. The values of $1/n$ and α are also tabulated for the other gases at different temperatures. The value of $1/n$ approaches asymptotically the value 1 as the temperature rises, the temperature at which this value is reached being the lower, the lower the critical temperature of the gas. The adsorbed quantity of gas may be represented over a large interval of temperature and pressure by the equation $\log a_t = \log a_0 = (\zeta - \xi \log p)t$, which is due to Freundlich, and in which a represents the quantity of gas adsorbed by 1 gm. of charcoal, and ζ and ξ are constants which are connected with the constants α and $1/n$ by the relations: $\zeta = -d/dt\,.\,(\log \alpha)$, $\xi = d/dt\,.\,(1/n)$. Deviations from this equation occur at temperatures which are near to the liquefying points of the various gases. The heats of adsorption of nitrogen, carbon dioxide, and ammonia were also measured and found to be in good agreement with those calculated from the equation given by Freundlich in his book ("Capillarchemie"), namely, $-q = (nRT^2/\log e)(\zeta - \xi \log p)$. [See Abstract No. 187 (1909).] T. S. P.

550. *Corrosion of Aluminium and Aluminium Utensils.* **E. Heyn** and **O. Bauer.** (Königl. Materialprüfungsamt, Mitt. 29. 1. pp. 2–28, 1911.)—About fifty samples of Al in the form of sheet and various utensils have been tested in water and various solutions of salts, with a view to elucidating the cause of corrosion of, and the nature of the accompanying efflorescent growth on aluminium cooking utensils. The results show that Al may be subject to two kinds of decay: (*a*) uniform attack of the whole surface owing to conversion of Al into hydrated oxide, and (*b*) local attack accompanied by scaling and the formation of blisters, this action being particularly severe, since the formation of a comparatively small amount of aluminium hydroxide results in considerable decay. Exposure of sheet Al to the atmosphere alone, or air-free water alone, results in no corrosion, the simultaneous presence of water and air being necessary as is the case with iron. The hardness of the metal determines to a large extent the nature of the corrosion: soft Al is usually attacked uniformly, but hard-drawn Al blisters and exfoliates in lines agreeing with the direction of rolling, the pressing from a circular sheet resulting in these lines being straight on the bottom and curvilinear on the sides of a pressed cylindrical vessel. The harder the Al, the more liable it is to local attack, and annealing at 450° C. entirely removes this tendency, the corrosion of annealed sheets being quite uniform. Distilled water and solutions of several salts such as sodium and calcium chloride produce uniform corrosion. The concentration of the salt solution has a great effect on the amount of action, in every case a certain definite concentration producing the most deleterious effect. The composition of the Al has little or no effect on the degree of corrosion. Greasing the vessels with vaseline decreased the tendency to corrode. To diminish the corrosion the authors propose that the Al should either be less severely cold-worked or that it should be subsequently annealed at 400–450° C. to reduce its hardness, but at the same time point out that this reduces the mechanical strength of the material. F. C. A. H. L.

551. *Brown Gold.* **Hanriot.** (Comptes Rendus, 151. pp. 1355–1357, Dec. 27, 1910, and 152. pp. 138–141, Jan. 16, 1911.)—"Brown gold," the spongy residue left when an alloy of Au and Ag containing about 20 per cent. Au is extracted with nitric acid, still contains a small amount of silver, and traces of Cu and Pb. It changes colour on heating, and undergoes considerable contraction; at about 900° C. it gives off gases, and at about 1040° melts with conversion into ordinary gold. The contraction of various alloys, both when treated with nitric acid, and when subsequently heated, has been determined. In the former case the shrinkage is found to vary from 24 per cent. of the length of a thin bar, for an alloy containing 78 per cent. Ag, to 0·3 per cent. for an alloy containing 50 per cent. Ag. It is independent of the temperature of the acid, and is constant for alloys of the same composition. The contraction due to heating takes place slowly, reaching a maximum after about 5–6 hours, and, above 250°, increases with rise of temperature, being for one alloy 21·8 per cent. of its length at 200° and 40·8 per cent. at 950°. Thickness of the strip and rate of heating have no effect on the final contraction, which varies greatly with the composition of the alloy, at 950° ranging from 44·5 per cent. to 18·1 per cent. for alloys containing 78 and

50 per cent. Ag respectively. The contraction taking place both during nitric acid treatment and on subsequent warming, is very much reduced if the alloy has not been sufficiently heated during stamping into plates. W. H. St.

552. *Critical Phenomena of Dissolution of Mixtures examined under Variable Pressure.* **J. Timmermans.** (Konink. Akad. Wetensch. Amsterdam, Proc. 13. pp. 507–526, Dec. 22, 1910.)—The mixtures selected were cyclohexane and aniline, whose critical temperature of dissolution, C.T.D. = 81·05°, rises on compression; nitrobenzene + hexane, C.T.D. = 21·00°; and nitrobenzene + isopentane, C.T.D. = 82·20°, whose critical temperatures of dissolution fall on compression. The physical constants of the constituents were—

	B.P.	F.P.	Density.
Isopentane	27·95°	− 158·55°	0·68942
Normal hexane	68·95	—	0·67718
Cyclohexane	80·75	+ 6·5	—
Aniline	184·40	− 6·17	1·03895
Nitrobenzene	210·85	− 8·70	1·22290

The critical temperatures of dissolution were measured up to 250 atmos., and were found to vary according to laws which had been deduced from theoretical considerations. T. M. L.

553. *Effect of Temperature on the Equilibrium* $2CO \rightleftarrows C + CO_2$. **T. F. E. Rhead** and **R. V. Wheeler.** (Chem. Soc., Journ. 97. pp. 2178–2189, Nov., 1910.)—A careful redetermination of the equilibrium ratio was made by the authors. The use of catalysts was avoided. The method adopted was to circulate CO_2 continuously over purified wood-charcoal packed in a porcelain tube and heated in an electrical resistance furnace. The apparatus used consisted of an electric resistance furnace in which the porcelain tube containing the carbon was placed. The ends of the tube were water-jacketed so that the equilibrium attained in the heated zone might be fixed. The gases were circulated by means of the circulation apparatus designed by Wheeler in conjunction with W. A. Bone. The temperature was measured by a Pt—Pt-Rh thermo-couple embedded in the middle of the carbon, and the measurements were recorded by a "Thread Recorder." The temperature in the furnace was automatically regulated. The gases were removed from the apparatus and analysed at varying intervals of time. The results obtained show a marked discrepancy from those obtained by Boudouard. The rates of the two reactions $CO_2 + C = 2CO$ and $2CO = C + CO_2$ at 850° C. show that the reactions are monomolecular, and the constant is calculated from the expression $K = 1/t \cdot \log(C_0/C_1)$. F. J. B.

554. *Wet Oxidation of Metals.* I. *Rusting of Iron.* **B. Lambert** and **J. C. Thomson.** (Chem. Soc., Journ. 97. pp. 2426–2438, Dec., 1910.)—The authors have taken extraordinary precautions to prepare chemically pure iron, water, and oxygen, and have demonstrated that these materials showed no reaction after standing together in clear fused silica vessels for several months. The presence of the slightest trace of impurity, even the small amount introduced from the use of Pt-vessels during the preparation of the pure materials, gives rise to rapid rusting. All commercial irons rapidly rust under the conditions of experiment, and the authors consider it proved that pure iron will not undergo visible oxidation in contact with pure oxygen and water, any rusting under such conditions being due to small traces of impurity. F. C. A. H. L.

555. *Rusting of Iron.* **V. Andström.** (Zeitschr. Anorg. Chem. 69. 1. pp. 10–21, Nov. 16, 1910.)—The author describes briefly the theories for the rusting of iron, and has carried out experiments in which polished iron plates were exposed to the action of both distilled and tap-water in flasks which were completely filled and closed by glass stoppers and mercury seals. In this way it was possible to keep the amount of oxygen present under observation. The tap-water used was the Helsingfors supply and contained in mgm. per litre, 108·6 total solids, 86·0 SO_3, 7·26 free CO_2, 18·2 combined CO_2 and 14·82 dissolved oxygen. The action of the water was allowed to continue for 200 hours, but in most cases was complete after 60 hours, and the amount of rusting found by determining the iron in the filtered liquid and in the residue. In well-boiled, distilled, and tap-water the amount of rusting was practically nil. The experiments with the tap-water and also in tap-water in which the CO_2-content had been raised to 28·18 mgm. per litre, showed that the amount of rusting was quantitatively proportional to the quantity of oxygen present, the function of the CO_2 being to dissolve its corresponding amount of hydrated iron oxide as $Fe(HCO_3)_2$. The result of the rusting is an oxidation product belonging to the ferro-ferric series. To prove this view of the action of CO_2 plates were exposed to the action of distilled water, whose CO_2-content had been raised to 451·5 mgm. per litre, the oxygen figure standing at 0·82, for 24 days. The results showed that the rusting proceeded at a very slow rate. The action of the CO_2 is quite secondary in that it acts as a solvent for the hydrated oxide first formed, thus leaving the surface clean and ready for fresh attack by the oxygen.

F. C. A. H. L.

556. *Absorption of Hydrogen by Kathodes and the Effect of this upon Polarisation.* **E. Rumpf.** (Akad. Wiss. Wien, Sitz. Ber. 119. 2a. pp. 957–975, June, 1910.)—The effects due to occlusion and loosening of the surface structure are dealt with experimentally, and as the result it is found that the metals Pd, Pt, Ag, Pb, and Hg have the power to take up large quantities of hydrogen when they act as kathodes in dilute sulphuric acid. In this way the surface of the solid metals undergoes a breaking-up or loosening. The polarisation of the kathode is dependent upon the quantity of hydrogen taken up, which raises the potential, and also upon the condition of the surface. In this manner it is explained how it is that the given values for hydrogen polarisation are not in good agreement. A. E. G.

557. *Electrolytic Separation of Radio-active Products from a Solution of Radium Residues.* **H. Sirk.** (Akad. Wiss. Wien, Sitz. Ber. 119. 2a. pp. 937–948, June, 1910.)—The paper deals with the separation of RaE, [see Abstract No. 1258 (1910)] and RaF from a solution of radio-lead acetate. For very small currents RaF (polonium) only is deposited on the kathode, but when the current density rises to over $1·1 \times 10^{-4}$ amp. RaE begins to be deposited, the amount being proportional to the time for the same current, increasing with increasing intensity more slowly than the current, and being apparently independent of the concentration. If the electrode (silver) is left in the solution the activity due to RaE is found to disappear in 10 min. The author finds the half-period of RaE to be 4·8 days. E. M.

558. *Electro-chemistry of Polonium.* **A. R. Johnson.** (Amer. Electrochem. Soc., Trans. 18. pp. 165–168; Discussion, pp. 168–170, 1910.)—The author finds that Pol is deposited on Cu and not on Hg, and deduces its single potential to be about —0·8 volt. However, as the series is passed up to metals of higher single potentials, precipitation does not necessarily occur all the more readily, for while Bi precipitates Pol readily, lead and iron or zinc appear to act rather indifferently. The author has also made experiments on the electrolysis of very dilute solutions of Pol, and finds it to move with the current in electrolysis as do real metals although not completely. Not all the Pol present is deposited at the kathode, probably owing to the very small concentration. In another experiment an active anode was prepared by depositing Pol on a sheet of Pt coated with an exceedingly thin film of Cu. With a Pt kathode the thin film of Cu would disappear from the anode in a few minutes, but the Pol required as many hours to pass to the kathode. By making use of this time factor it is possible to separate Pol from Cu. The author deduces from the various experiments that the atomic weight of Pol is either exceedingly small or its valency very great. E. M.

559. *Some Practical Applications of Overvoltage Phenomena.* **C. Hambuechen.** (Amer. Electrochem. Soc., Trans. 18. pp. 91–95; Discussion, p. 95, 1910.)—According to the generally accepted theory, the corrosion of metals is caused by galvanic couples due to impurities or electronegative elements in the metal under consideration, and the rapidity of corrosion will then be dependent principally upon two factors, namely, the resistance of the local circuits and the e.m.f. of the couple considered as a primary cell. There is, however, a third and more important factor, namely, the supertension or overvoltage values; for example, a couple of zinc and tin would have an e.m.f. of 0·588 volt if there were no supertension, but owing to this latter the actual e.m.f. is only 0·088 volt. Thus while the potential series indicates that tin is as bad an element as iron for producing corrosion on zinc, the correction for overvoltage shows that tin is really far less harmful. The author gives practical examples of the application of these results to the cleaning of silver ware and the prevention of boiler corrosion. T. S. P.

560. *Rapid Determinations and Separations by means of the Mercury Kathode and Stationary Anode.* **R. C. Benner** and **M. L. Hartmann.** (Amer. Chem. Soc., Journ. 32. pp. 1628–1636, Dec., 1910.)—The authors have compared the results obtained with a stationary anode with those obtained with a rotating anode, a mercury kathode being used in all cases. The rates of deposition of Cu, Ag, Ni, Co, Zn, and Fe, and also the quantitative character of the results, were studied. Under like conditions of current, volume of solution, &c., although the rate of precipitation with the rotating anode is greater than with the stationary anode, it is not sufficiently so to recommend the use of so much more complex a piece of apparatus. The results are as accurate as those obtained by means of other mercury kathode methods. With the different metals investigated it is possible to use about the same conditions as in the determination by means of the rotating anode and mercury kathode. [See Abstract No. 180 (1911).] T. S. P.

561. *Estimation of Silver by Electro-deposition from an Ammoniacal Solution of the Oxalate.* **F. A. Gooch** and **J. P. Felser.** (Amer. Journ. Sci. 31. pp. 109–111, Feb., 1911.)—25–50 c.cm. of silver nitrate solution, containing 0·2687–0·5875 gm. of Ag are completely precipitated with ammonium oxalate. The silver oxalate is dissolved in a slight excess of ammonium hydroxide and the solution, diluted to 100 c.cm., is electrolysed with a current of

0·25–1·5 amps. at 4–7 volts, using a rotating kathode consisting either of an ordinary Pt crucible, or of a Hildebrand double disc electrode [see Abstract No. 1266 (1907)], or of a gauze cone set point downwards upon the axis of rotation. The kathode with the deposited Ag is dried over a low flame and then heated to incipient redness. The time of deposition is 25–30 min., and the results are accurate. The best form of kathode is the gauze cone kathode. Experiments with stationary gauze electrodes were not successful, nor were those made with a disc kathode and rotating anode. Satisfactory results may also be obtained when the Ag is first precipitated as chloride and then deposited from the solution of the chloride in ammonium hydroxide and ammonium oxalate; the deposits are dark and spongy, but they become lighter in colour and more compact on drying. **T. S. P.**

REFERENCES.

562. *Rectilinear Diameter of Oxygen.* **E. Mathias** and **H. Kamerlingh Onnes.** (Konink. Akad. Wetensch. Amsterdam, Proc. 13. pp. 939–956, March 28, 1911. Communication No. 117 from the Phys. Lab., Leiden.)—The full paper corresponding to Abstract No. 1582 (1910).

563. *Recent Advances and Problems in Chemistry.* **E. Fischer.** (Nature, 85. pp. 558–563, Feb. 23, 1911. Lecture delivered on the occasion of the founding of the Kaiser-Wilhelm Society for Advancement of Science, Jan. 11, 1911.)—The author traces the relations between science and scientific industries in Germany, pointing out that by affording facilities for the prosecution of pure scientific research technical industry can only gain. **L. H. W.**

564. *Infectious Diseases of Metals.* **E. Cohen.** (Elektrochem. Zeitschr. 17. pp. 181–185, Oct.; 248–250, Dec., 1910, and pp. 277–279, Jan., 1911.)—The author gives a *résumé* of the researches on "tin plague" and the "mechanical decay" of tin [see Abstract No. 750 (1910)]; and as there is no connection between the phenomena, a better name is proposed for the latter, viz., "hardening disease," since the decay is intimately bound up with the cold-hardening of the material. A similar phenomenon has been observed in a sheet-brass vessel. **F. C. A. H. L.**

565. *Mathematical Theory of the Changes of Concentration at the Electrode, brought about by Diffusion and by Chemical Reaction.* **T. R. Rosebrugh** and **W. L. Miller.** (Journ. Phys. Chem. 14. pp. 816–834, Dec., 1910.)

566. *Electrolysis of some Cyanides.* **H. E. Patten** and **W. R. Mott.** (Amer. Electrochem. Soc., Trans. 18. pp. 83–89, 1910.)—The following series of results have been obtained: (*a*) The relation between the current and e.m.f. when normal aqueous solutions of potassium cyanide, potassium cyanate, potassium thiocyanate, and potassium ferrocyanide were electrolysed between Pt electrodes. (*b*) The anodic and kathodic polarisation values at polished Pt electrodes when normal potassium ferrocyanide was electrolysed with different current densities. (*c*) The relation between the current and e.m.f. and also the discharge potentials for mixtures of potassium cyanide with solutions of the sulphates of Mg, Cd, and Cu respectively. (*d*) The anodic and kathodic polarisation values of solutions of potassium cyanate and thiocyanate. The decomposition points obtained for the various electrolytes from a consideration of the curves plotted from the above results are given, and also the variation of these points with the current density. **T. S. P.**

SCIENCE ABSTRACTS.

Section A.—PHYSICS.

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